The Blast Furnace and Steel Plant

Vol. XII PITTSBURGH, PA., AUGUST, 1924 No. 8

Politics and Business

THE July letter of the National City Bank of New York, discussing the effect of politics on business, says in part: "Most of the questions that are referred to in political speeches and conventions relate to industry and business, and there appears to be no reason for any radical departure upon these matters from the public policies of this country as maintained heretofore. While it would be too much to say that there is nothing that the government can do to promote the prosperity and welfare of the country, two general propositions may be safely stated:

"First, that the government has much greater power to injure the country through bad legislation affecting industry and business than to benefit it through legislation touching those subjects, and, second, that there are greater opportunities to benefit the country by repealing laws now on the statute books, thus correcting past mistakes, than by passing new laws.

"Industry and business have little to gain from legislation. Prosperity comes by the free and voluntary activities of individuals in industry and the exchange of services, and the government can do little beyond facilitating these activities. It has no creative powers except as it draws on the individual powers of its citizens, and the latter are able to organize and direct their own efforts much more effectively than the government can do it. If anything has been demonstrated by experience it is that political governments are not successful in the management and direction of business affairs."

Boiler Operation at High Ratings

Trumbull Steel Combines Pulverized Coal Methods in Power House and Heating Furnace

By **H. A. REICHENBACH***

WHAT is generally conceded to be a most excellent example, both in design and operation, of a pulverized coal installation is in operation at the main plant of the Trumbull Steel Company, Warren, Ohio. In fact, a member of the Fire Underwriters' Association, after visiting virtually all of the pulverized coal plants in the country, proclaimed it "the best and cleanest I have ever seen." His visits to the various plants were in an official capacity and extended over a period of three years.

The management and engineer of the Trumbull Steel Company decided on the adoption of pulverized coal for boilers and metallurgical furnace firing after extensive investigations convinced them of its economies over all other methods of firing. In 1920 they contracted with the Fuller-Lehigh Company for a complete pulverized coal preparation plant, conveying systems, and burning equipment for three boilers and metallurgical furnaces. These are the first units of the plant which, when completely changed over to pulverized coal firing, will constitute 63,000 square feet of boiler heating surface, 17 double chamber furnaces, 64 sheet and pair furnace and two jobbing mill furnaces.

Pulverized Coal Preparation Plant; Crushing and Raw Coal Storage.

The pulverized coal preparation equipment is housed in a building of structural steel frame with tapestry brick walls. Run-of-mine and slack bituminous coal is delivered to a 60-ton twin concrete coal car track hopper at the southeast corner of the milling room. The coal discharges from the track hopper by gravity to either of two pan conveyors through shut-off valves. These pan conveyors discharge into a 30x30 in. single roll Jeffrey crusher of 50 tons per hour capacity where run-of-mine coal is crushed to 1¼ in. size. This is the first step in the production of what ultimately will be a "mechanical-gas" fuel.

By referring to the longitudinal sections 1 and 2 and the transverse sectional elevations, AA, BB, CC, DD, the path of the fuel through the process of drying, pulverizing and conveying can readily be traced.

The preliminary crusher discharges to a 20 in. belt conveyor which carries the coal up a 17-deg. incline,

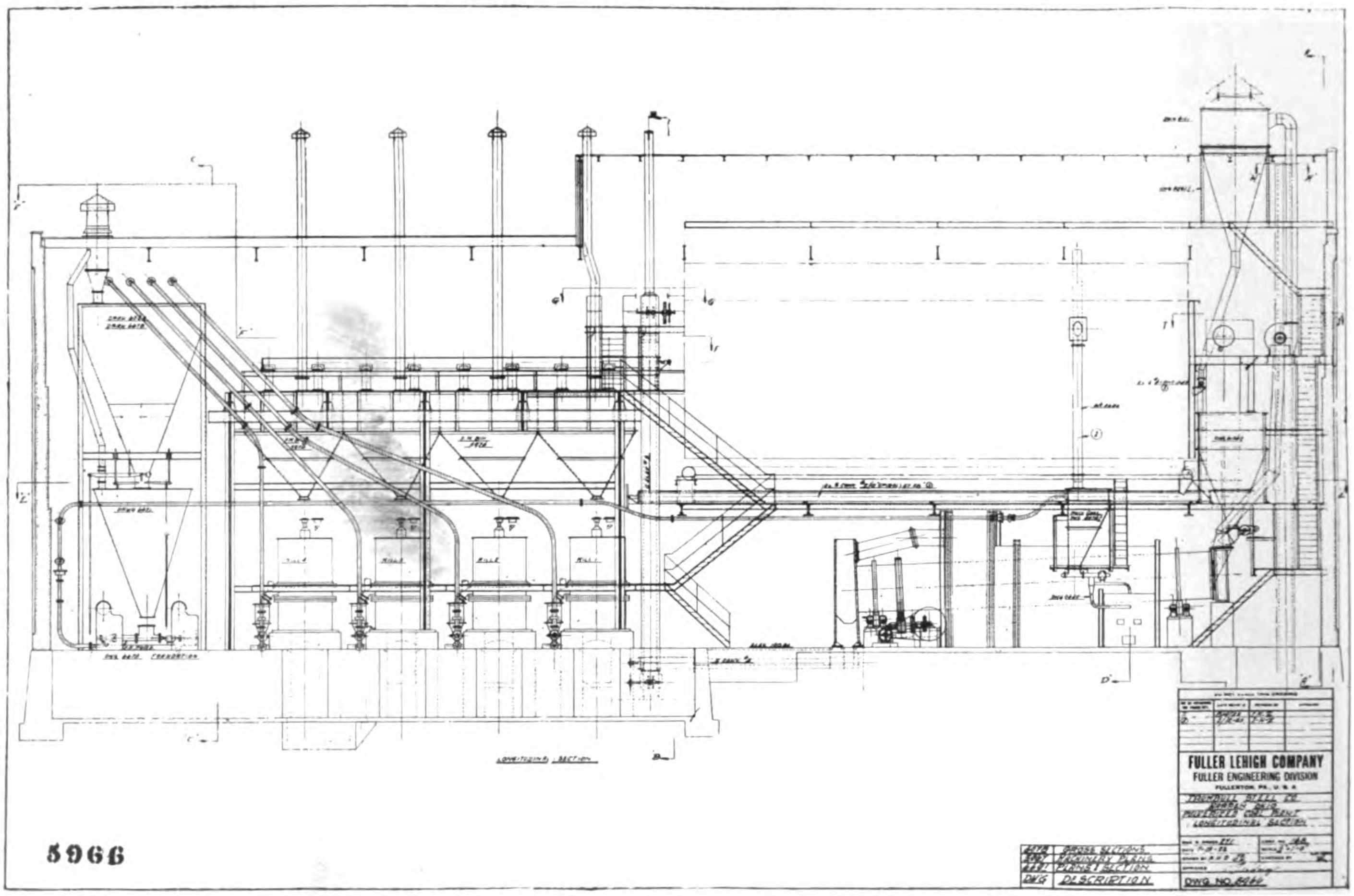

FIG. 1—*Cross section through coal preparation plant.*

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*General Engineer, Fullerton, Pa.

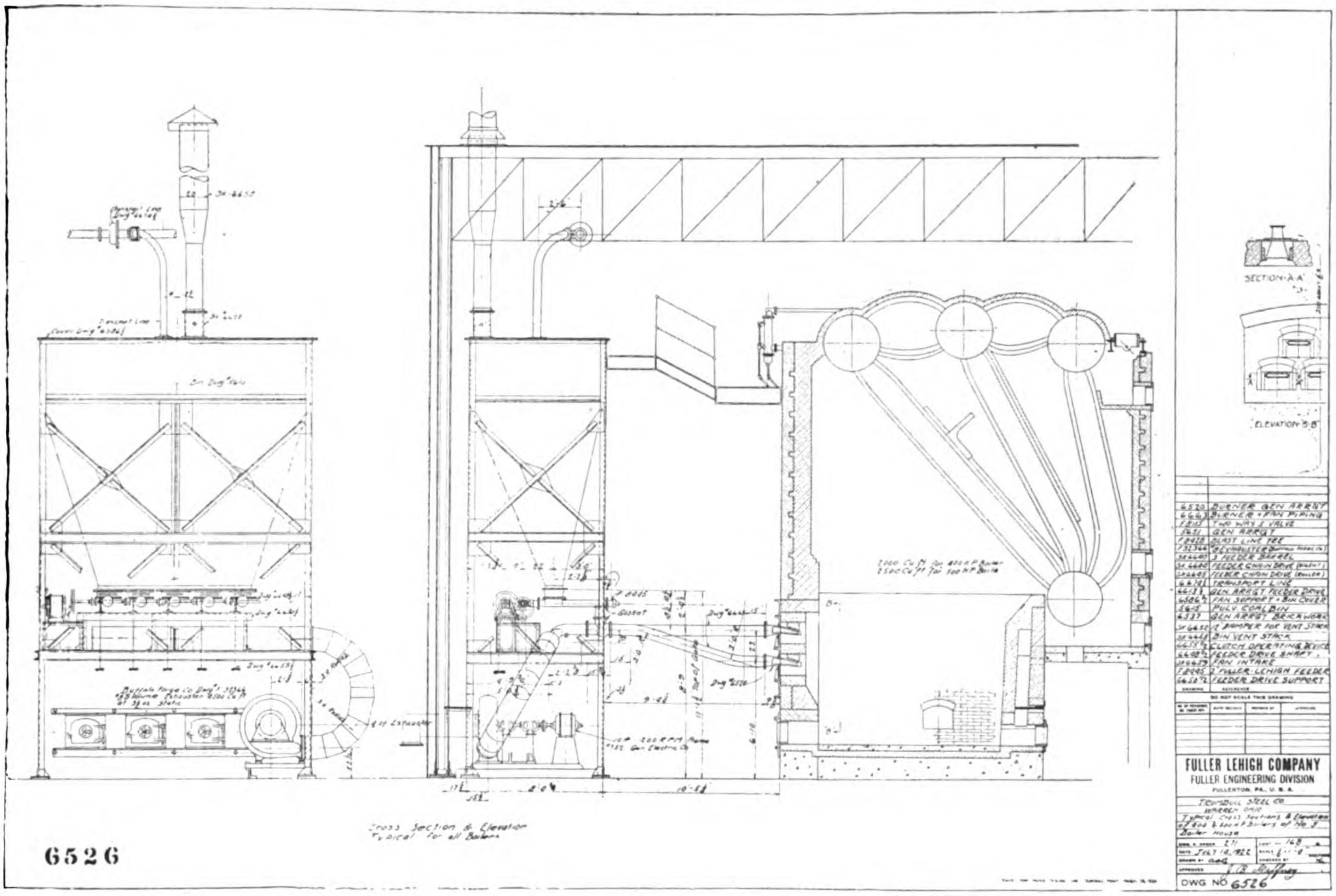


FIG. 2—*Cross section through boiler house, showing bin arrangement.*

delivering into the boot of a Jeffrey crushed coal elevator No. 1, thence to screw conveyor No. 2, which discharges the green or undried coal into a 600-ton suspended bunker.

On the bottom of the bunker extending throughout its length are placed 15 coal gates at regular intervals discharging onto an 18-in. belt conveyor, which carries the crushed coal to the boot of elevator No. 2, which delivers it to two 15-ton raw coal storage bins serving the driers. (Sec. AA.) Connecting the elevator discharge with the 15-ton bins is a twin discharge spot equipped with a throw-over butterfly valve so arranged that the full flow of coal can be directed to either bin or the stream can be divided, delivering a part to both bins simultaneously. The coal is delivered in a uniform stream to each drier by an adjustable 11-ton per hour capacity cradle feeder attached to the bottom of each bin hopper. These bins are provided with electric high-level bin indicators, which automatically light an electric bulb, thus advising the operator when the material reaches a certain high level.

Drying.

The coal is dried by two Fuller-Lehigh 5 ft. 6 in. by 42 ft. indirect fired rotary driers using pulverized coal for fuel. (Fig. 1 and Sec. AA.) Each dryer is driven through a gear train and Morse silent chain by a 25-hp. constant speed General Electric motor. The fuel for firing is fed from a 3-ton storage bin by a 3-in. screw feeder driven by a motor through silent chain and Reeves speed regulator. The fuel is injected vertically into the combustion chamber and a blast of secondary air is projected into the furnace horizontally from a 3-in. pipe so that it engages the fuel mixture immediately below the burner tip, thus inducing prompt ignition and quick combustion. A No. 3 type "B" Buffalo blower supplies the primary and secondary air.

The spent gases are exhausted from the dryer shell by a No. 8 Buffalo forge exhauster driven by a 10-hp. direct connected motor. They are discharged into a cyclone separator where the entrained particles of any dust in the gases are settled out by gravity into the collecting screw No. 6, carried to screw No. 7, which discharges into the main stream of coal in elevator No. 3. The unburdened gases pass from the cyclone through a washer, thence out into the atmosphere.

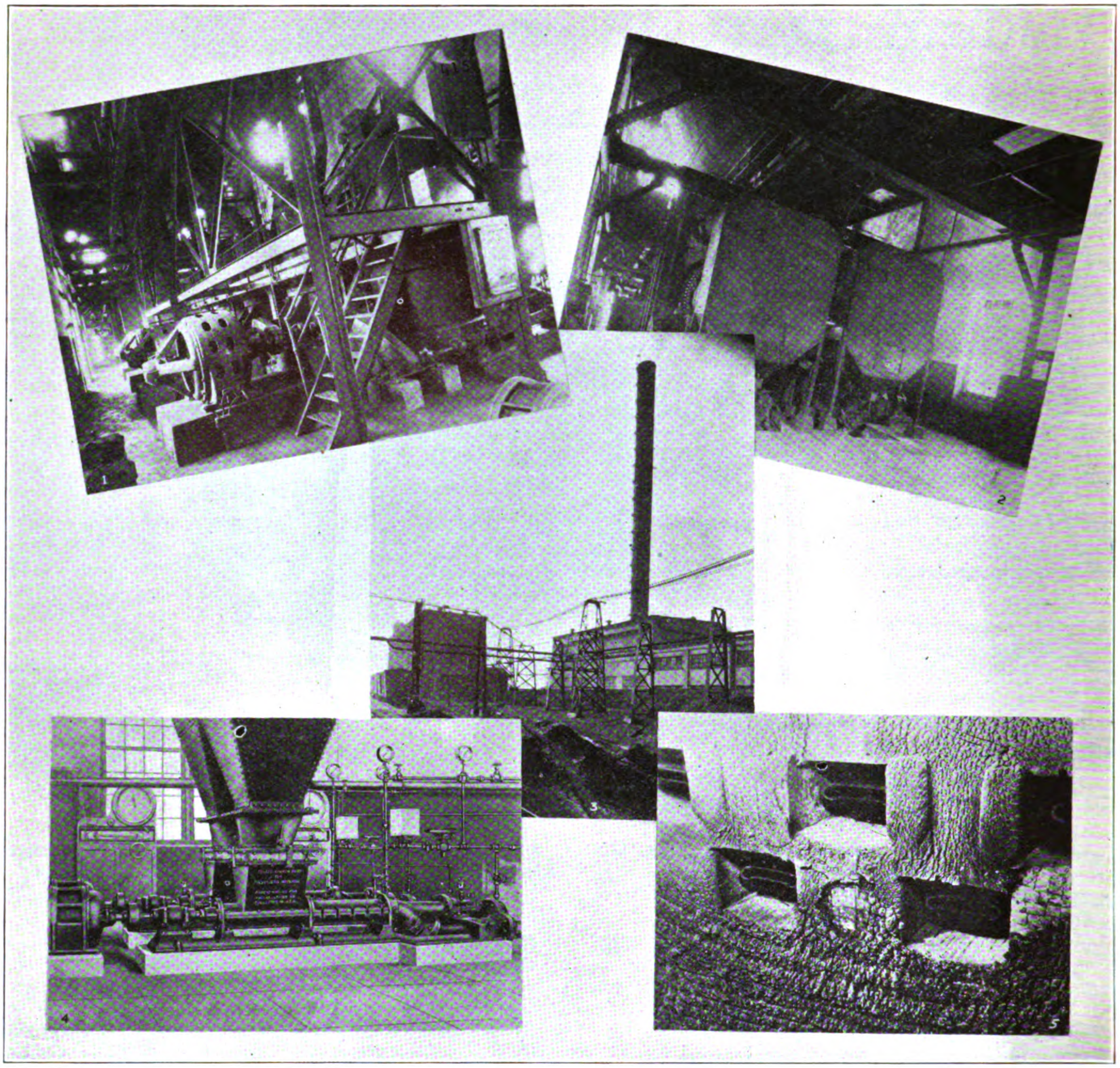
A thermocouple is located in the discharge end of each coal dryer; this is connected to a Brown recording pyrometer conveniently located, which facilitates temperature regulation and control.

The dryers discharge through a chute to screw conveyor No. 4, which carries the coal to the boot of elevator No. 3, thence to screw conveyor No. 5, which serves the pulverizer bins.

At the bottom of the spout connecting each dryer discharge with screw conveyor No. 4, there is a 15x24 ft. Ohio Electric & Controller Company magnetic separator which removes all tramp iron from the coal.

Pulverizing.

The coal is pulverized by four Fuller-Lehigh 57-in. screen-type gear-driven mills, each served by a cradle



Upper Left—View through preparation plant. Foreground—Four 57-in. Fuller-Lehigh Pulverizers, each discharging into a Fuller-Kinyon pump. Background—Fuller-Lehigh driers.
Upper Right—Two 5 ft. 6 in. by 42 ft. Fuller-Lehigh indirect fired driers showing magnetic separators in discharge spout.
Center—Left—Pulverized coal preparation plant. Right—Boiler house.
Lower Left—Two pumping units of the conveying system. Each supply bin is connected to an indicating dial scale.
Lower Right—Furnace side of front wall of boiler.

feeder from an individual 12-ton capacity storage bin. The mills are driven by direct connected motors through Francke couplings and bevel gears. A 10-ton Yale chain hoist mounted on an overhead double channel trolley which extends over all the mills facilitates repairing and maintenance of pulverizers.

Each mill discharges directly into the hopper of a 6-in. type "C" Fuller-Kinyon pulverized coal pump. The pumps are driven by a Morse silent chain from the mill pinion shaft. The hp. required for this mill and pump drive is 125 to 130 with a mill output of 8.5 tons per hour, the air pressure on the conveying line being 20 pounds.

Conveying.

Each of the four Fuller-Kinyon pumps attached to the mills delivers the pulverized fuel through a 4-in. pipe line and two-way diverting valves into either of two 40-ton storage bin, located at the extreme western end of the coal plant. Below the 40-ton storage bins and connected therewith by a 12-ounce flexible canvas joint and butterfly valves, are four 5-ton weigh bins, each mounted on a Fairbanks, direct dial, reading scale of 10,000 pounds capacity. All the pulverized coal leaving the plant is weighed and an accurate account is kept of the fuel delivered to the various furnaces.

Four Fuller-Kinyon pumps, one under each weigh bin and connected therewith by a flexible canvas joint, pumps the coal through a 5-in. pipe line to the boiler bins, annealing furnace bins and dryer fuel bins. The maximum distance in each case being 300 ft., 1300 ft. and 150 ft., respectively. The conveying lines are so interconnected with the four pumps by double diverting valves so that any pump can be used to deliver fuel to any furnace bin in the system.

Remote Control for Distribution System.

The flow of pulverized coal from the pumps to the furnace bins is remotely controlled by push button electrical connections on a switching and indicating board conveniently located in the milling room. Each pulverized coal bin is equipped with a high-level and low-level electric bin indicator which automatically shows when the material reaches a certain predetermined high or low level by extinguishing and lighting electric bulbs on the switchboard. Each diverting valve has electrical connections with bulbs on the switchboard which register the position of the valve, i. e., whether the valve is open for flow through the branch line and closed to the main line or vice versa. The diverting valves are electro-pneumatically operated either from the switchboard by push button control or are automatically thrown by the electric bin indicators. The valve disc is operated through levers by air pressure applied to one of a pair of air cylinders through a needle valve which in turn is actuated by a pair of electric solenoids. The solenoids are in circuit with the high level indicator and as soon as it is detected by the rising material in the bin an electric connection is closed through a mercoid switch which excites the solenoid, thus raising the needle valve. Compressed air is admitted to the air piston which throws the valve disc from the open to closed position, thus stopping the flow of the material to that particular bin and directing it to the next successive one.

Boilers.

The initial installation comprises two Stirling boilers of 4,000 square feet and one Stirling boiler of 5,000 square feet heating surface. Each boiler has a furnace designed for 200 per cent of rating, and is horizontally fired by five 6-in. Fuller flare type burners placed in staggered relation in two tiers. Individual 16-ton capacity storage bins serve the boilers from which the pulverized fuel is fed to the 4-in. burner pipes by five 3-in. Fuller-Lehigh single screw feeders. The feeders are driven from a gang shaft through Brown clutches and gears by one hp. d.c. Reliance motor with field control speed variation ranging from 500 rpm. to 1500 rpm. The maximum speed of the feeder screw is 320 rpm.

A No. 8 Buffalo Forge blower at each boiler provides the primary air for combustion at 3-ounce pressure. The secondary air is induced through the adjustable air inlet doors around the burners and through the front and rear clean-out doors.

Draft is provided by a self-supporting stack 9 ft. in diameter by 210 ft. high, which is capable of accommodating four boilers operating at 200 per cent rating. The boilers are connected to the stack by steel plate breeching.

The water fed to the boiler is measured in a Cochrane metering heater and a Bailey steam flow meter records the steam output from each boiler.

Probably the most remarkable feature of this installation is the consistent high ratings at which the boilers are operated. With furnaces originally designed for 200 per cent, they have averaged 275 per cent over monthly periods with peak loads of 325 per cent for several hours' duration.

BOILER CHARACTERISTICS

Number (set singly)	Three
Make	Stirling
Class	Two 521 and one 527
Rating	2 400-hp. and 1 500-hp.
Setting height of floor to center line of mud drum	10 ft. 0 in.
Baffling	3 pass regular
Furnace Vol. (400 hp.)	2000 cubic feet
Furnace Vol. (500 hp.)	2500 cubic feet
Length of furnace—burner tip to bridge wall	10 ft. 6 in.
Width of furnace (400 hp.)	10 ft. 6 in.
Width of furnace (500 hp.)	13 ft. 6 in.
Thickness of bridge wall at base	2 ft. 10¾ in.
Thickness of front wall at bottom	2 ft. 3 in.
Thickness of front wall at top	1 ft. 10½ in.
Thickness of side wall at bottom	2 ft. 7½ in.
Thickness of side wall at top	1 ft. 10½ in.

The coal is pulverized so that 75 per cent passes through a 200-mesh sieve. The boilers are operated with an average CO_2 content in the stack gases of 13 per cent.

Motor Groups and Features of Motor Control.

All the equipment is driven by individual motors through silent chains, reduction gears, or by chain sprocket. Each motor is provided with push button start and stop control.

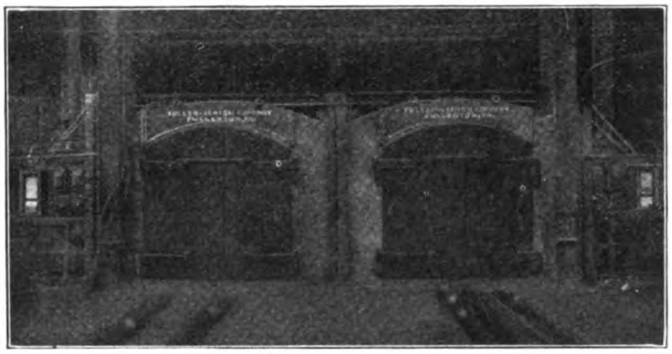


FIG. 3—*View of the annealing furnace.*

The Fuller mill motors operate with 2200 volts, 3-phase, 60-cycle current; all of the other smaller motors are energized by either alternating or direct current of 220 volts.

The motors are interlocked in three main groups. If, for any reason, any motor in a single group stops, all the others in that group stop also, thus arresting the progress of the material through the system and avoiding any tendency toward clogging elevators or feeders.

Group No. 1 includes No. 1 elevator, Jeffrey crusher, pan conveyor and the conveyor belt from the crusher to elevator No. 1.

Group No. 2 includes No. 3 elevator motor, dryer, burner, feeder, and the dryer cradle feeder.

Group No. 3 comprises pulverized coal feeders on each boiler and the corresponding fan drive for primary air. If the latter fails, the coal feed to that boiler is automatically stopped.

It will probably have been noted that the installation for preparing pulverized coal is sufficient to provide 750 tons of fuel per day when operating 22 hours. This is far in excess of the amount required at present. However, when pulverized fuel was decided on by the management, they planned to put in prepara-

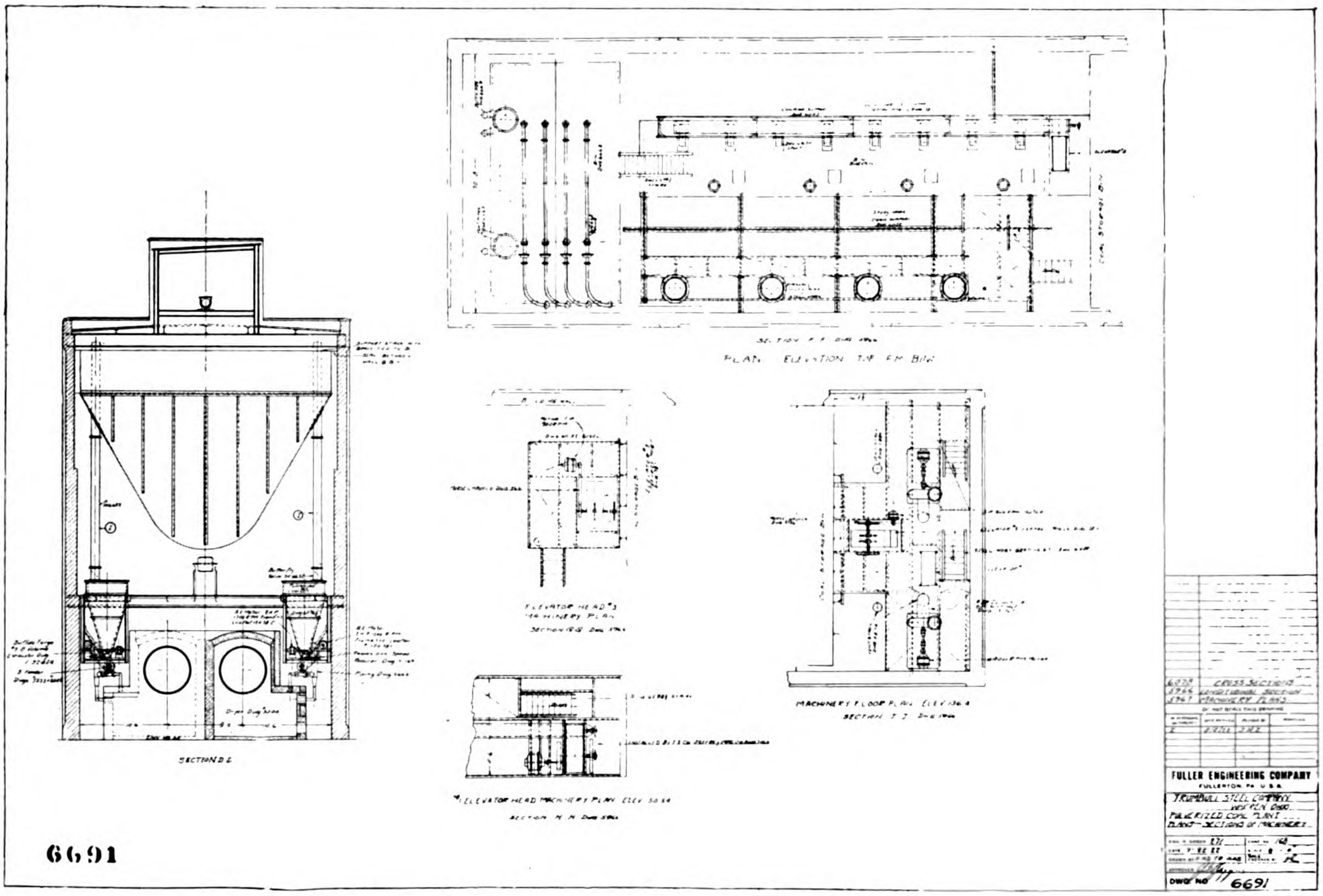
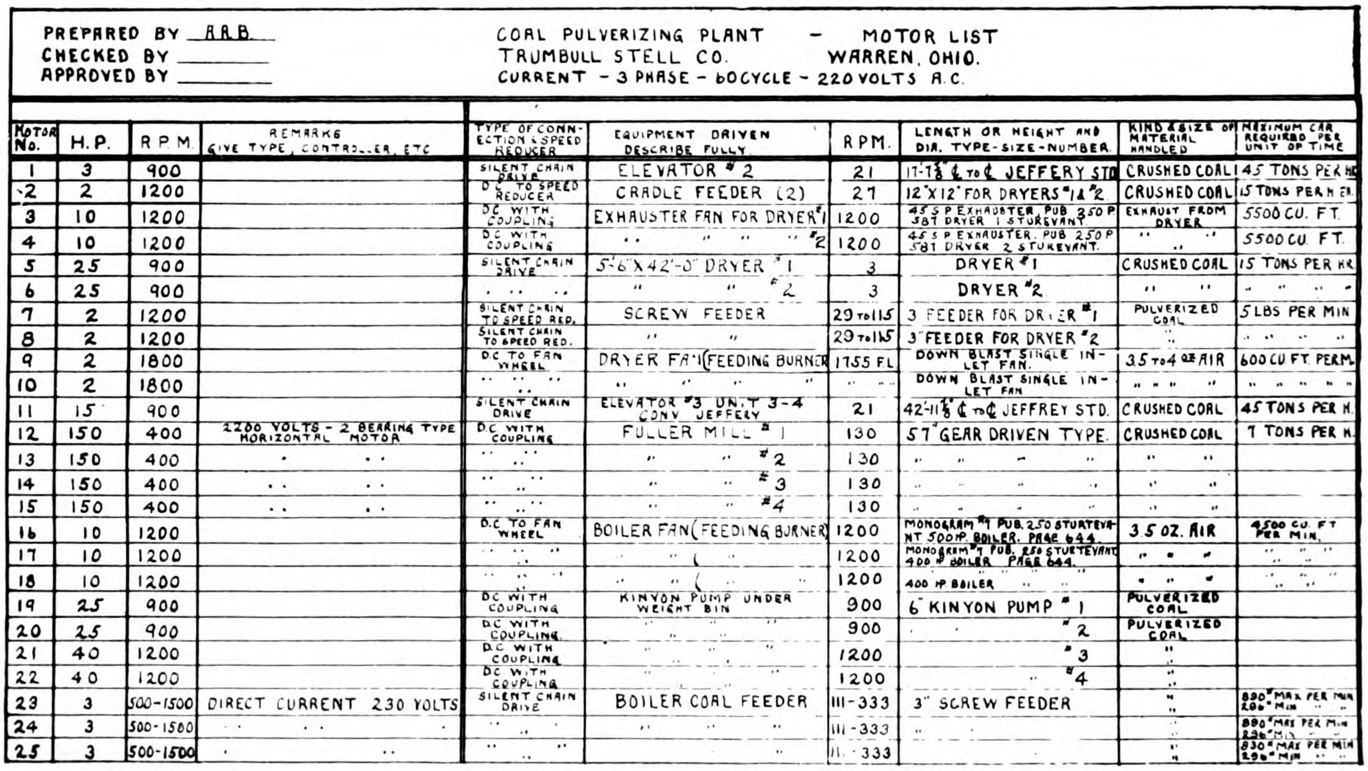

6691
SECTION D-E
PLAN ELEVATION TOP OF BIN
ELEVATOR HEAD #3 MACHINERY PLAN
MACHINERY FLOOR PLAN
ELEVATOR HEAD MACHINERY PLAN
6979 CROSS SECTIONS
5766 LONGITUDINAL SECTION
5767 MACHINERY PLANS
FULLER ENGINEERING COMPANY
FULLERTON, PA. U.S.A.
TRUMBULL STEEL COMPANY
WARREN, OHIO
PULVERIZED COAL PLANT
PLANT—SECTIONS OF MACHINERY
DWG NO 6691

FIG. 4—*Details of coal storage and distribution.*



PREPARED BY ARB
CHECKED BY
APPROVED BY

COAL PULVERIZING PLANT - MOTOR LIST
TRUMBULL STELL CO. WARREN, OHIO.
CURRENT - 3 PHASE - 60 CYCLE - 220 VOLTS A.C.

MOTOR No.	H.P.	R.P.M.	REMARKS GIVE TYPE, CONTROLLER, ETC	TYPE OF CONNECTION & SPEED REDUCER	EQUIPMENT DRIVEN DESCRIBE FULLY	R.P.M.	LENGTH OR HEIGHT AND DIA. TYPE-SIZE-NUMBER	KIND & SIZE OF MATERIAL HANDLED	MAXIMUM CAP. REQUIRED PER UNIT OF TIME
1	3	900		SILENT CHAIN DRIVE	ELEVATOR #2	21	17'-7 1/8" ℄ TO ℄ JEFFERY STD	CRUSHED COAL	45 TONS PER HR
2	2	1200		D.C. TO SPEED REDUCER	CRADLE FEEDER (2)	27	12"X12" FOR DRYERS #1 & #2	CRUSHED COAL	15 TONS PER H ER.
3	10	1200		D.C. WITH COUPLING	EXHAUSTER FAN FOR DRYER #1	1200	45 S.P. EXHAUSTER, PUB 250 P 58T DRYER 1 STURTEVANT	EXHAUST FROM DRYER	5500 CU. FT.
4	10	1200		D.C. WITH COUPLING	.. " " " #2	1200	45 S.P. EXHAUSTER. PUB 250 P 58T DRYER 2 STURTEVANT.	.. ..	5500 CU. FT.
5	25	900		SILENT CHAIN DRIVE	5'-6"X42'-0" DRYER #1	3	DRYER #1	CRUSHED COAL	15 TONS PER HR
6	25	900		.. .. ..	" " #2	3	DRYER #2	" "	" " " "
7	2	1200		SILENT CHAIN TO SPEED RED.	SCREW FEEDER	29 to 115	3" FEEDER FOR DRYER #1	PULVERIZED COAL	5 LBS PER MIN
8	2	1200		SILENT CHAIN TO SPEED RED.	" "	29 to 115	3" FEEDER FOR DRYER #2	..	.. ..
9	2	1800		D.C. TO FAN WHEEL	DRYER FAN (FEEDING BURNER)	1755 F.L.	DOWN BLAST SINGLE INLET FAN.	3.5 to 4 OZ AIR	600 CU. FT. PER M.
10	2	1800		.. .. ..	.. " " "	.. ..	DOWN BLAST SINGLE INLET FAN	" " " "	" " " " "
11	15	900		SILENT CHAIN DRIVE	ELEVATOR #3 UNIT 3-4 CONV JEFFERY	21	42'-11 1/8" ℄ TO ℄ JEFFREY STD.	CRUSHED COAL	45 TONS PER H.
12	150	400	2200 VOLTS - 2 BEARING TYPE HORIZONTAL MOTOR	D.C. WITH COUPLING	FULLER MILL #1	130	57" GEAR DRIVEN TYPE.	CRUSHED COAL	7 TONS PER H.
13	150	400	. ..	.. ..	" " #2	130	" " - "	" "	
14	150	400	.. ..	.. ..	" " #3	130	.. ..	" "	
15	150	400	.. ..	.. ..	" " #4	130	" - - "	" "	
16	10	1200		D.C. TO FAN WHEEL	BOILER FAN (FEEDING BURNER)	1200	MONOGRAM #7 PUB. 250 STURTEVANT 500 HP. BOILER. PAGE 644.	3.5 OZ. AIR	4500 CU. FT. PER MIN.
17	10	1200		.. .. ..	" ("	1200	MONOGRAM #7 PUB. 250 STURTEVANT 400 HP BOILER PAGE 644.	" " "	" " "
18	10	1200		.. .. ..	" " (" "	1200	" " " " 400 HP BOILER " "	" " "	" " "
19	25	900		D.C. WITH COUPLING	KINYON PUMP UNDER WEIGHT BIN	900	6" KINYON PUMP #1	PULVERIZED COAL	
20	25	900		D.C. WITH COUPLING	" " "	900	" #2	PULVERIZED COAL	
21	40	1200		D.C. WITH COUPLING	" " "	1200	#3	"	
22	40	1200		D.C. WITH COUPLING	" " "	1200	" #4	"	
23	3	500-1500	DIRECT CURRENT 230 VOLTS	SILENT CHAIN DRIVE	BOILER COAL FEEDER	111-333	3" SCREW FEEDER	"	890# MAX PER MIN 296# MIN " "
24	3	500-1500	.. .. .	.. ..	" " "	111-333	"	"	890# MAX PER MIN 296# MIN " "
25	3	500-1500	. ..	.. ..	"	111-333		"	830# MAX PER MIN 296# MIN " "

tion equipment of sufficient capacity to take care of future requirements needed after all the boilers, metallurgical and industrial furnaces had been changed to pulverized coal fired types.

New Station for New York Edison Company

A new power station is to be constructed by the New York Edison Company with an ultimate capacity of 700,000 kw., it is announced by the General Electric Company with whom the order for the first two turbine-generators has been placed.

These turbine-generators have a rated capacity of 60,000 kw. at unity power factor, 25 cycles, 11,400 volts, 3 phase, to run at 1500 rpm. These machines will operate at 350-lb. steam pressure, 700 deg. F. maximum temperature. They will be equipped with direct connected exciters and will exceed by 10,000 kw. capacity the present largest single unit machines now operating. The machines are scheduled for delivery during the spring of 1926.

Redesigned Resistance Starter

A new design of manually operated, enclosed resistor starter can be used for starting squirrel cage induction motors up to 20 hp., 550 volts, under light load. The resistance is proportioned to give an inrush current of 3½ times the normal full load motor current, permitting the motor to develop at least 50 per cent full load torque in starting.

The starter is made by the General Electric Company and is of the safety type, completely enclosed with ventilated case, externally operated and provides overload and undervoltage protection. It is furnished with a single step resistor, equal parts of which are connected in each phase. The switching elements are of the contact finger type, strong and readily renewable.

Mellon Institute Industrial Fellowships

Director Edward R. Weidlein's annual report to the Mellon Institute Committee of the Trustees of the University of Pittsburgh gives the status of the Industrial Fellowship System at the end of the Institute's fiscal year, on February 29, 1924. The accompanying list of fellowships is taken from this report, which mentions that the Institute now has available for distribution to all interested persons a new booklet, entitled "Industrial Fellowships," which describes the history and research system of the institution.

At the close of the Institute's fiscal year, 52 industrial fellowships were in operation, employing 83 research chemists and engineers. The sum of $412,132 was contributed for sustaining this work by the industrial fellowship donors. Two new fellowships were accepted, to begin on March 1 and April 1, respectively, and at present (May 1, 1924) there are 53 fellowships in the Institute, which is filled to approximate capacity by the activities of the incumbents.

The total amount of money donated by industrial firms to the Institute for the 13 years ended February 29, 1924, was $2,719,103. During the same period the Institute itself expended $494,580 in defraying overhead expenses — salaries of members of the executive staff and office force, maintenance of the building, purchase of books and apparatus, etc. — in the operation of the industrial fellowships. Besides this amount, the Institute has invested in a building and permanent equipment for research on all types of technochemical problems.

The list of industrial fellowships shows the breadth and diversity of the Institute's work. This list includes 33 individual and 19 multiple fellowships. Two of the multiple fellowships (Nos. 377 and 385) have been in operation since 1911, 26 other fellowships have been at work for three or more years, and 11 fellowships are in their second year of operation. Industrial Fellowship 386, which was founded on March 1, 1923, is a resumption of the smoke investigation carried on during the period 1912-14. Industrial Fellowship 382, established on July 23, 1923, is a continuation of a research conducted in 1917 and 1918. Industrial Fellowship 364, on dental alloys, which began on February 1, 1922, was terminated on January 1, 1924, upon the completion of its investigational work the incumbent of this fellowship was J. W. Harsh (B.S., University of Illinois).

The industrial fellowships which have been founded by associations of manufacturers are listed below.

Most of the Institute's researches for associations have for their purpose the advancement of basic knowledge of the industries, their processes and products. It has been especially successful in work on standardization of factory practice and manufactured products and on extending uses of various chemicals and commodities.

Nos.	Names	Donors	Company Members in Associations
366	Refractories	Refractories Manufacturers Association	90
367	Magnesia products	Magnesia Association of America	2
370	Vitrified tile	Clay Products Association	31
371	Vitrified tile	Eastern Clay Products Association	19
372	Cleaning	Mundatechnical Society of America	9
379	Stove	Stove Founders Research Association	14
384	Art tile	Associated Tile Manufacturers	13
387	Edible gelatin	Edible Gelatin Manufacturers Research Society of America, Inc.	10
391	Laundering	Laundryowners National Association	2066
393	Carbon dioxide	Carbon Dioxide Division, Compressed Gas Manufacturers Association	52
397	Fiber	National Container Association	76
404	Meat products	Institute of American Meat Packers	266
410	Insecticides	Rex Research Bureau	5
413	Metal ware	Sheet Metal Ware Association	16

A Correction

Frank Hodson, president of the Electric Furnace Construction Company, Philadelphia, Pa., points out that an error occurred in the captions of the first two photographs illustrating the article on Electric Furnace Development, page 314, July issue of The Blast Furnace and Steel Plant. The Soderberg electrodes illustrated in these photographs are installed on 6-ton Heroult type furnaces at Rehmscheid, Germany, and not the Ford Motor Company. The other photographs are correctly described.

THE SAFETY CRUSADE

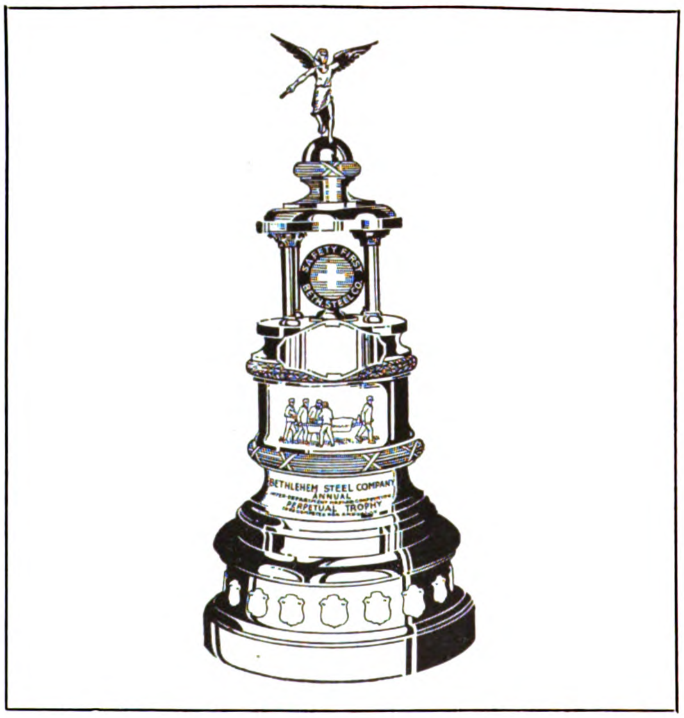
"One of the Most Important Planks in the Platform of Good Business"

This is the title of President E. G. Grace's June talk to the Bethlehem employes. He continues as follows:

"In the course of the past eight years the number of Bethlehem accidents in proportion to the number of employes has been reduced by 40 per cent. However, the accidents which still occur in our plants from day to day are witness to the fact that we have room for improvement.

"One of Bethlehem's big jobs is to reduce still further the number of accidents to men in the steel plants, shipyards and mines. Accidents are undoubtedly the largest single item of avoidable waste in our manufacturing costs.

"Accident prevention work pays three-fold returns: There is a return to the employer in lower costs, a return to the employe in a physical and monetary saving, and a return to the community through a lessening of care for the maimed and disabled. Any one of these alone justifies the furtherance of the work, but taken in the aggregate they constitute one of the most important planks in the platform of good business."

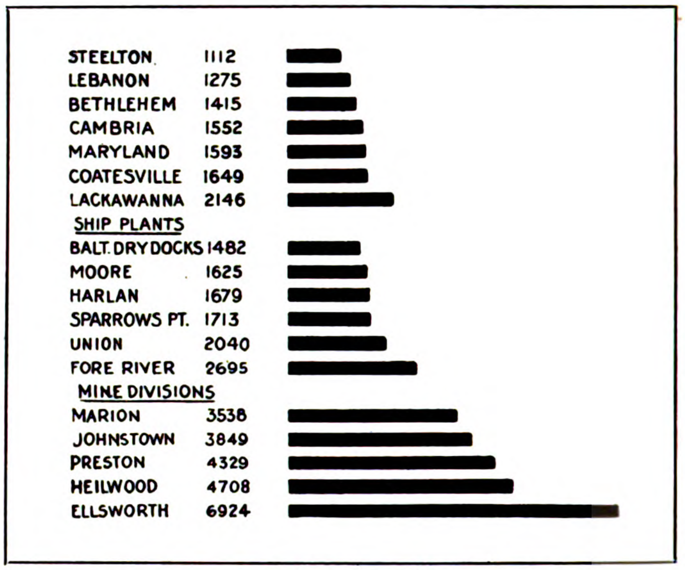


The Bethlehem Safety Trophy

What Bethlehem Employes Can Gain Through Avoiding Accidents

Some may think of accident prevention as a subject for pictures, safety weeks and chamber of commerce drives, but of little real importance in the affairs of the business world.

As a matter of fact, the greatest annual loss to industry is through accidents. Among the 41,000,000 persons gainfully employed in the United States last year 2,500,000 met with serious accidents. These accidents caused a loss of 227,000,000 working days. Figured at a wage of $4.50 per day, accidents mean a loss to wage earners of $1,022,000,000 in wages during the year 1923. The loss of time due to accidents last year was equivalent to 757,000 men being out of employment for the entire year.



Cost of Accidents to Bethlehem Families.

A man who is hurt suffers pain and worry. His family loses a part or all their income. Bethlehem accidents last year will cause a total loss of 38,000 pay envelopes to Bethlehem families, each pay envelope representing the average pay for a two weeks' period. This loss will exist even after including the compensation payments which the company has made and will make to its employes or their families.

Accidents Cost the Company $2,000,000 in 1923.

Accidents and their treatment took almost $2,000,000 out of the corporation's treasury last year. This amount includes compensation paid to the men who were hurt and the cost of necessary hospital work. This expense amounted to 1.7 per cent of the total payroll for the year, and was approximately equivalent to the dividend on Bethlehem's 7 per cent preferred stock for six months.

Who Pays Compensation?

While compensation helps to relieve the distress of men who are hurt, it must be paid out of the same income that pays wages—the money received from the sale of iron and steel products. Neither the company nor the employes, nor the community, receive any productive benefit from payments made as compensation for accidents.

Causes of Accidents.

Accident prevention work becomes, after a plant is adequately, physically protected, a matter almost entirely of vigilance and education, and this constitutes the basis of Bethlehem's present program.

Last year there were 5,199 lost time accidents among Bethlehem's employes; 83 of these were fatal and 55 caused amputations or lost eyes. It may be noted that more than 50 per cent of all Bethlehem accidents result in injuries to the employes hands or feet, largely to the ends of fingers or toes.

The following table, showing by percentages the causes of Bethlehem accidents, indicates the activities in which care is most needed to prevent accidents:

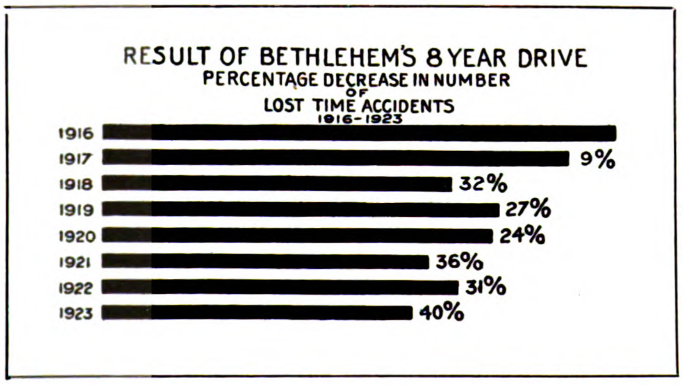
Handling material	22 per cent
Falling or tripping	16
Falling material	14
Handling tools	12
Stepping on or striking against objects	9
Burns	6
Machinery	5
Flying particles	4
Engines and cars	1
Miscellaneous	11
	100

Accident Standing of Steel Plants, Ship Yards and Mines.

The relative standing of Bethlehem's various steel plants, shipyards and mines in number of working days lost through accidents during the past twelve months is shown in the following table:

Results of Bethlehem's Accident Prevention Work.

Bethlehem's vigilant accident prevention policy during the last eight years has reduced by 40 per cent the number of accidents in the plants per 1,000 employes, and has reduced the number of fatal accidents by 25 per cent. It is estimated that this reduction has resulted in a saving to the employes and to the company of $3,000,000.



The fatal accidents in Bethlehem's steel plants, compared with the fatal accidents in the entire steel industry as published by the U. S. Department of Labor, show that Bethlehem's rate is 12 per cent better than the average for the industry. Similar comparative improvement in number of fatal accidents is shown by Bethlehem's mines and shipbuilding plants.

(Note—Because the accident hazards in the steel, shipbuilding and mining industries are not comparable, the three groups are shown separately.)

The figures in the following table show fatal accidents per 1,000 full time workers:

	Latest Estimate for the Industry	1923 Figures for Bethlehem Plants	Bethlehem's Improvement Over Average for Industry
Steel	1.35	1.19	12 per cent
Shipbuilding	1.33	.38	71 per cent
Mines	4.08	3.60	12 per cent

The reduction of the number and seriousness of accidents in Bethlehem plants during the past eight years, as well as the relatively better fatality standing of Bethlehem, shows what can be accomplished in the direction of accident reduction. The fact that Bethlehem employes suffered over 5,000 lost time accidents last year shows that there is still great opportunity for improvement.

It Dropped!
Most "Bethlehem" Accidents result in injuries to hands and feet.
Handle Materials Carefully!

A typical poster.

75-Ton Storage Battery Locomotive

A 75-ton storage battery locomotive, the largest size as yet actually built in this country, has been put in operation at the Schenectady plant of the General Electric Company, for use on the interconnecting track systems of the plant and for operation in restricted areas where overhead or other outside current collection is impossible or impractical.

This locomotive is a double-truck, four-motor unit with a central operator's cab and batteries arranged in compartments at either end. It is equipped with contactor control and automatic airbrake equipment. The storage battery, which consists of 100 cells, has a total capacity of 1,080 ampere-hours, or 216 kwh. The locomotive was built at the Erie plant of the General Electric Company and may also be operated with a pantograph, collecting power from overhead wires.

Color Classification of Blast Furnace Slags

An Attempt to Demonstrate the Underlying Principles Which Result in Definite Slag Characteristics

By **WALLACE G. IMHOFF***

PART II

The More Complex Magma of Silica, Lime and Alumina.

So far our molten magma has consisted of only two components, silica and lime. It has been clearly shown that as the silica decreases and the lime increases, there must be a corresponding rise in temperature or melting point of the magma. We are now in a position to introduce a third component and to show just what effect it will have on the melting point and slag composition.

Alumina, Al_2O_3, according to many prominent observers, melts at 2050 deg. C. Therefore we may once again look at our components from the standpoints both of a constant slag volume and of changing slag volume. There has been some doubt as to the part that alumina plays in slags.[1] By some it has been regarded as an acid, by others as a base, and by still others, as either an acid or a base, depending on the conditions present. The author has found it distinctly a base and never an acid. Our magma may assume a composition represented as follows:

PLATE 6

1. Constant and changing slag volume.

The first magma with the three components may be represented by the diagrams labeled Constant Slag Volume. Fig. 1 shows a slag that has plenty of silica for both the bases lime and alumina and perhaps even an excess of silica. When poured into the mold the excess silica at once freezes, then the lime silicate, then the aluminum silicate. This magma is represented by the actual slag below:

The second magma with the three components may be a slag with the same volume but more bases, as shown by Fig. 2. Thus when such a magma cools the silica will freeze out as a small glass edge, then the aluminum silicate, and due to the high lime the lime silicate will freeze out last. Such a slag from actual practice is seen below:

The third magma shows that the line has become the main component. The silica content has become so small that when the slag is molten there is no free silica at all, but the magma is composed entirely of lime and aluminum silicates. When this slag is poured in the mold the aluminum silicate freezes up at once and then the lime silicate. An example of this magma is illustrated by the actual slag type below:

Another magma with approximately the same composition showed a slag sample as follows:

The first slag sample to the left in the front row of Plate VI is an actual slag sample of this type.

The components of slags are automatically changed by the change in slag volume caused by increase or decrease in silica. In practical operation the slag volume is always changing more or less due to this cause. The second series of slags are represented by the series of figures 4, 5, 6 and 7, of changing slag volume.

Fig. 4 shows a large percentage of silica and bases and a typical example is the cream white basic lime silicate slag shown in Plate VII.

Fig. 5 shows a large proportion of alumina and bases with a smaller slag volume than Fig. 4. Such a slag would be represented by the hard blue stony type of slag.

Fig. 6 shows a slag with a large slag volume but high silica. Any of the glass slags would represent this type. A lean slag on a basic furnace is an example.

Fig. 7 shows a slag with low silica and low lime. This slag is a typical high aluminum slag found on foundry iron furnaces. It would probably show a glass edge and a blue center.

2. Silica constant; variation in temperature and bases.

We are now ready to take up the discussion of magmas containing both lime and alumina a little deeper. In order to derive a definite magma we will assume conditions as illustrated in Case I.

The features of interest are then:

SiO_2	$CaSiO_3$	CaO, M. P. 2570° C.
SiO_2, M. P. 1600-1750° C.	Al_2SiO_5	Al_2O_3, M. P. 2050° C.

The total amount of available silica for the magma is constant; alumina is practically a constant, so that the lime or bases will be the changing component. Just how this sort of a magma acts is illustrated by the diagrams. In Fig. 1 the bases are shown to be both alumina and lime. At the given temperature each has an equal attraction for the silica which is divided between them. Due to the high silica and low bases the whole slag temperature is low.

Now assume more limit is put on and the temperature is raised, the total amount of silica remaining constant. Fig. 2, Case I, illustrates this condition. The temperature must be higher to melt the increased lime, but the lime also requires more silica, hence a higher silicate of lime and also a higher aluminum silicate since some of the silica from the former aluminum silicate was taken for the lime.

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*Metallurgist, Pittsburgh, Pa.

[1] The Effect of Alumina in Blast Furnace Slags. By J. E. Johnson, Jr., A.M.I.E. December 1912.

Function of Alumina in Slags. By C. Henrich, A.M.I.E. Bull. 119; 2081-6, N'16.

In Fig 3, Case I, the lime is still further increased with the result that still more of the silica must be used up. Therefore the melting point is raised still more, and higher lime and aluminum silicates are formed. It actually happens in practice that at times the lime is increased to so great an extent that the slag will slack and go to powder when cold. This is due to the extreme shortage of silica which gives a slag body, and its stony, vitreous properties. It is interesting in this connection to compare the glassy appearance of the slags shown in Plate VII with the dry grainy fracture of the samples in Plate VIII. The latter are so high in lime that some of them slacked to powder.

In Case II the amount of available silica is low at all times so that at the outset it is recognized that the temperature must be considerably higher than in Case I. The same general changes take place as in Case I, but the illustration shows how the temperature is affected, or in practice how the slag composition is determined by the temperature and available amounts of slag components.

Type of Blast Furnace Slags.

Having described how the alumina always acts as a base, we will now take an actual slag type and describe the magma that made it.

All the illustrations given have been taken from actual slag samples so that it remains to try to interpret correctly just what has happened. In the above figure the magma first contained a large excess of silica, second it was at a high temperature as shown by the green glass which is characteristic of a hot lean slag. The proportions of lime and alumina were both low as evidenced by the proportion of glass to the remaining segregated lime and aluminum silicates.

When the slag was poured into the slag-box the cold sides of the iron slag-box caused the silica to freeze out at once. The middle of the sample is always last to cool and freeze. Finally the temperature fell through the range at which the white lime silicate could remain liquid and it froze and the final or last part to remain liquid was the blue aluminum silicate.

The temperature determines at all times the variety of lime or aluminum silicate that shall be formed. As an example suppose we take another magma at a much lower temperature, which when cold gave the slag type below:

Here we have a much more complicated magma that is only medium hot. This fact is shown by the manganese in the slag which is a temperature indicator. The base or main body of the magma is seen to be a silicate with small quantities of manganese, for the green tinge shows that the slag is just on the border of being hot enough to reduce the manganese.

The next component or segregation unit is found in a thin yellow band of manganese silicate which as the magma cools represents the next higher freezing component. As the magma cools still further the next segregation unit is shown by the tan brown manganese silicate. This has a much higher melting point that the first or base of the magma. Finally the last component of the segregation of the magma is shown by the blue aluminum silicate center. The center of the slag is always the last to freeze and hence represents the highest freezing temperature.

Suppose we take an example of another magma that represents a large slag volume, and moderately high silica and lime. This slag type when cold is shown below:

The temperature of the magma is such that the base instead of being silica is the cream white lime silicate. The actual temperature of this slag is therefore higher than the one showing the glass edges unless this lime silicate has a melting point lower than pure silica, which may be entirely possible. The magma on cooling contained enough silica to form in addition the blue aluminum silicate, but under the conditions the temperature and the composition of the magma did not encourage its formation as shown by the very small amounts.

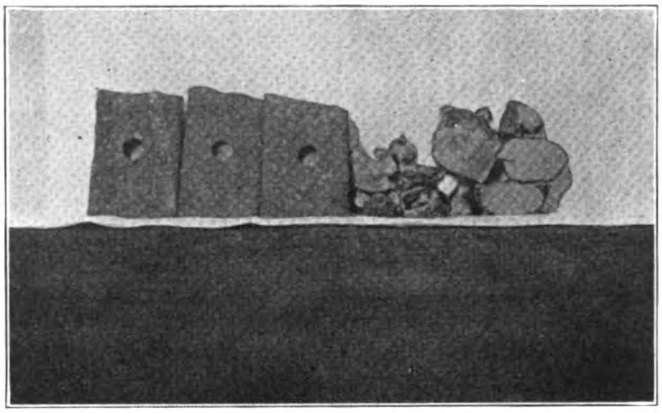
PLATE 7

To make a comparison with the magma just described and one which also shows small amounts of aluminum silicate another slag type is shown below:

What is the difference? The first feature noticed is that there is a striking difference in the amount of lime in the magma. This is shown by the base of the magma being a green glass. The temperature may be somewhere near the same, for both slags show small amounts of the blue aluminum silicate. This example illustrates the change due to slag composition.

A high base, low silica slag, will be a magma at a very high temperature. This is due to the predominance of the alumina and lime. Such slags when cold form the rocky, stony, blue slags. A typical type is shown in the illustration:

When a magma of this type cools the whole slag is practically uniform with no excess of silica. Therefore when it cools the whole thing freezes at once into a solid rock and no segregation of any kind taking place. The only trace of the presence of silica is to be seen in the somewhat vitreous fracture.

The above actual examples from slags of all kinds of furnace conditions will suffice to show that a blast furnace slag is simply a magma and follows the same general laws that govern magmas.

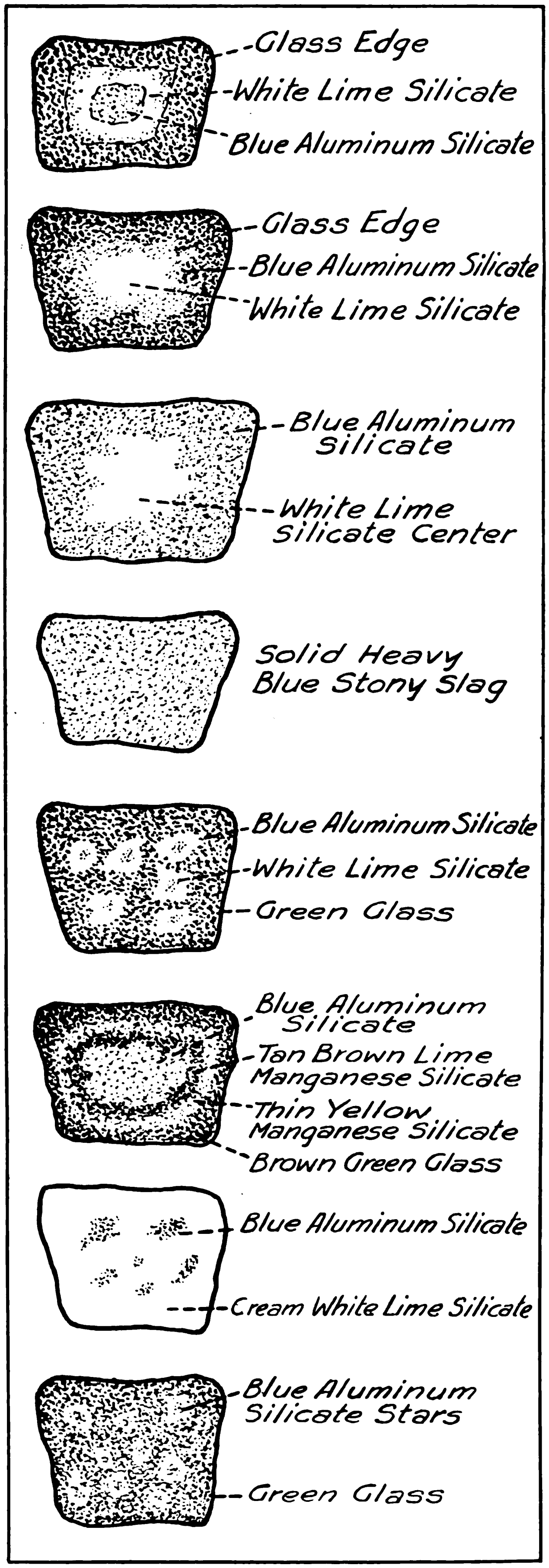

FIG. 3—*Classification of slags.*

Sulphur in Slags.[1]

The sulphur has not been mentioned so far for a number of reasons. We are now ready to inquire about sulphur and the sulphides. Sulphur is contained in slags in two ways, first, as sulphur gas in solution[2], and second, as calcium sulphide dissolved in a base of lime and aluminum silicates.

Sulphur gas held in solution is typical of lean glass slags. It can easily be recognized by the choking, suffocating smell from the thin blue fumes which rise from the slag as it runs to the cinder pit. These thin blue fumes can be plainly seen in Plate IX.

Calcium sulphide is a pure white powder and no doubt is familiar to most observers. The fundamental and only law governing sulphur in slags is that calcium sulphide is formed with a high hearth temperature. The law is simple, yet it is this law that seems hardest to understand. The simple solution is that a high hearth temperature reduces the silica which in turn leaves the lime for the sulphur and vice versa, a low hearth temperature sends the silicon into the slag as silica which uses up the lime from the sulphur.

The sulphides seem to be dissolved in the slag. Thus the sulphides may be considered separate but as constantly interchangeable according to the temperature. To show clearly just what is meant suppose that a total of 100,000 pounds of stone are used and of that amount 10,000 pounds are figured for the sulphur. This then leaves 90,000 pounds for the silica and alumina in the slag. If the furnace is hot and everything is running smoothly the 10,000 pounds are used to form calcium sulphide and this calcium sulphide is dissolved up in the slag magma.

The furnace becomes cold, the sulphur in the iron rises, and more lime is put on. But what is happening? As the furnace gets cold the silicon goes to the slag as silica. This must have lime. It takes it from the calcium sulphide and frees more sulphur. More lime is put on, and instead of the sulphur going down it keeps on going up. As the furnace becomes colder and more lime is put on the slag becomes infusible and the furnace may eventually become lime-set. This clearly shows lime should be taken off at this time and not put on, and the hearth temperature is raised.

Classification of Blast Furnace Slags.

(a) Temperature indicators.

1—Silica. The classification of blast furnace slags is based on two features, namely, temperature and slag composition. For the sake of convenience the temperature may be considered as hot, medium hot, and cold. The composition varies from acid slags to basic slags, with all types of slag composition between these two extremes.

The temperature indicators are silica, manganese and iron. Hot glass slags are a light bottle green color, changing to a dark green as the slag temperature falls. It will also be noted that hot glass slags are very shiny, clear and glassy, while cold glass slags

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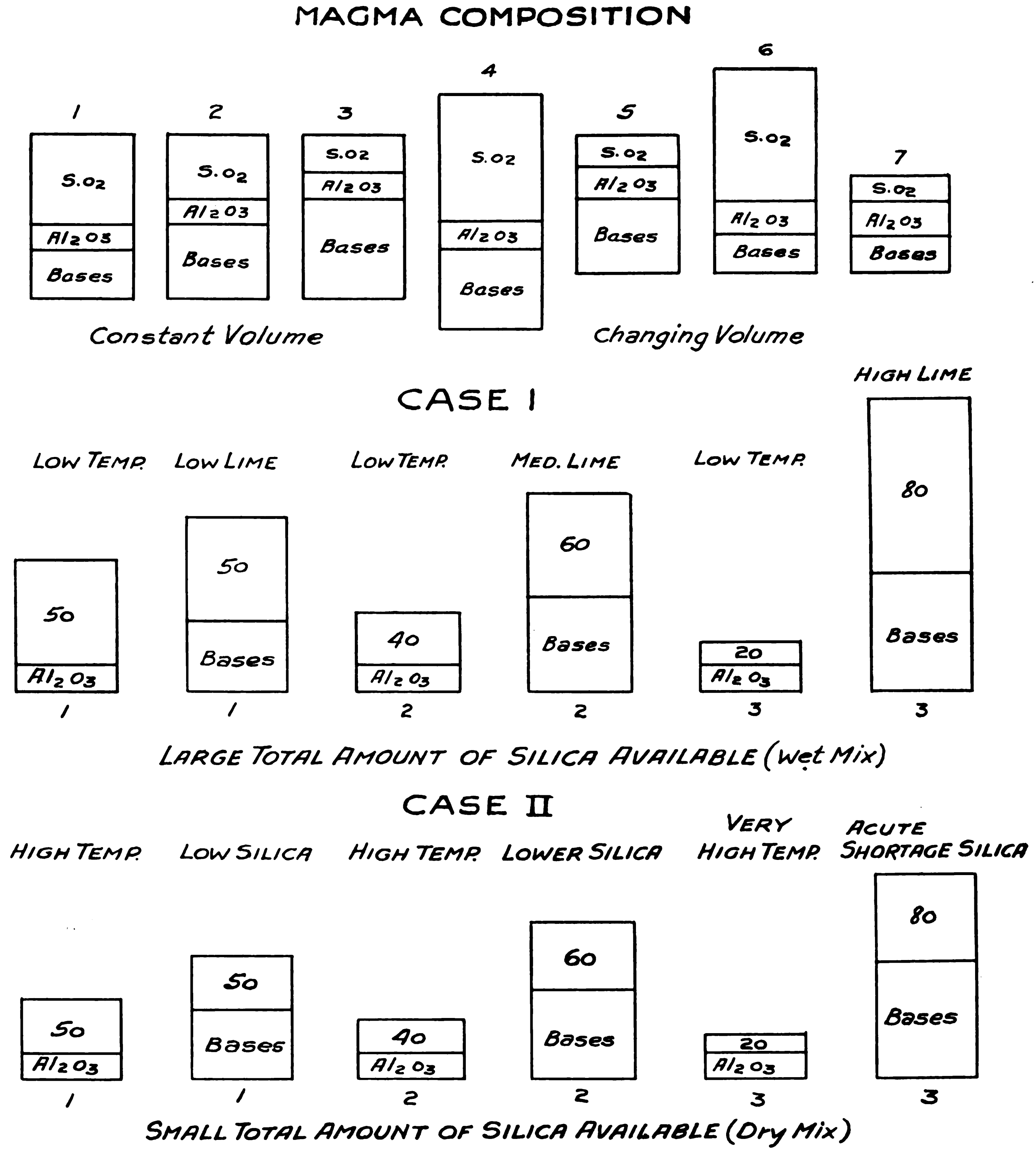
[1] Sulfur as a Component of Furnace Slags. By Wallace G. Imhoff. Blast Furnace and Steel Plant, July 1917.

Sulfur as a component of Furnace Slags. Part II. By Wallace G. Imhoff, Blast Furnace and Steel Plant, August 1917.

[2] The Operation of the Blast Furnace. By J. E. Johnson, Jr. Metallurgical and hemical Engineering. Vol. XIV, No. 7, p. 370.



are dull and cloudy looking. Silica is the highest temperature indicator for the hearth and must be hot to reduce silica to silicon. A white hot lime slag is low in silica, and as the silicon goes from the iron to the slag as silica, the hearth temperature gradually falls. Thus the amount of silica in the slag becomes an indicator of the hearth temperature.

2—Manganese. As the hearth temperature falls, if there is an appreciable amount of manganese present the slag will show a brown glass. This may be taken as the dividing line for hot slags and medium hot slags although great care must be exercised to fully understand the conditions present. Manganese will not go into the slag if there is very heavy lime on the charge. The lime makes the iron thick and dry and it will not take up the manganese regardless of how hot the furnace is. Manganese will go into the iron best on a hot lean furnace under which conditions the iron will be thin and fluid. It is very convenient, however, to use manganese as a temperature indicator. When manganese is present hot green glass slags turn brown as the furnace becomes colder. The

CLASSIFICATION OF BLAST FURNACE SLAGS.

	TYPE	HOT	MEDIUM HOT	COLD
ACID SLAGS	All Glass	Green Glass: Light green to dark green glass.	Brown Glass: Vitreous light brown to dull dark brown.	Black Glass: Shiny black glass; glass shot.
	Glass: Blue and white specks.	White specks (lime) in green glass. Blue specks (aluminum) in green " .	White specks in brown glass. Blue specks in brown glass.	Vitreous black glassy slags; black glass shot.
	Glass: Blue or white center	Blue center; green border glass. White center; green border glass.	Blue center; brown border glass. White center; brown border glass.	Black glass slags.
	Glass Edges.	White with green glass edges. Blue with green glass edges.	White with brown glass edges. Blue with brown glass edges.	Clouded black slags; dull glass shot.
	All white or all blue.	Cream white lime silicate slag. Blue aluminum silicate slag.	White and brown silicate slags. Blue and brown silicate slags.	Clouded black slags.
	Mixtures of white and blue.	White edge, blue center; various combinations of white, blue, and green glass.	White edge, blue center; various combinations of white, blue, and brown glass.	Clouded black slags.
	Stony slags.	Heavy, solid, blue, or gray stony slags.	Heavy blue, gray, and brown stony slags.	Heavy dull black stony slags. Dry black shot.
	Dry slags. Losing vitreous lustre.	Hot lime slags.	Brown and olive green lime slags.	Cold dry black slags; no cinder at flush time.
BASIC SLAGS	Dry grainy slags.	Dry white hot lime slags. (Grainy).	Heavy dry brown or dark olive green slags. (Grainy.)	Heavy dull black slags. Very dry. Huge heavy cakes.
	Powdered slags.	Slags which go to powder when left in the air. White or gray powder.	Heavy dark brown basic slag. Extremely dry and grainy	Extreme heavy, dry, crusty, black slags.

same is true of basic slags, the brown color generally indicates that the hearth is becoming colder.

3—Iron. The best, easiest and most reliable temperature indicator is iron. The two extremes of slag temperature are readily distinguished by the iron present. A hot lean slag is a light green glass; a cold lean slag is a black glass; a hot lime slag is pure white; a cold lime slag is black and all shades of both are found between the two extremes of temperature.

Iron colors slags black and is derived from the oxidation of the iron carried out as shot.[1] At this point it is of interest to again turn to Plate V and see how the iron increases as the slags vary from a very hot slag to a cold black slag. The degree of temperature for the given slag composition is indicated by the amount of black iron oxide formed.

(b) Volume change.

1—Change of temperature; change of analyses. When the burden for a furnace has been figured it does not indicate by any means that the iron and slag desired will be made. It is entirely possible to change both the iron and the slag by simply raising the fusion zone. Thus the complete composition of the slag may be changed by simply changing the hearth temperature. The lower the hearth temperature, the more silica goes to the slag and the larger the slag volume, and vice versa, the higher the hearth temperature the more silica there is reduced and hence the smaller the slag volume. This change of temperature causes a variation in the slag composition which is at once shown by the analyses. At times it is difficult to tell whether the furnace needs heat or lime.

2—Constant temperature; constant analyses.

From the previous discussion it is readily seen that when the temperature remains constant the slag analyses will remain constant, or in other words equilibrium is established. If the temperature begins to rise it may be lowered by increasing the wind a little or by increasing the size of the charge, both of which will increase the tonnage. If the variation is small, the temperature can be easily controlled simply with the available stove heat.

PLATE 8

(c) Chart classification of blast furnace slags.

This I believe is the first attempt ever made to classify blast furnace slags. The chart is based upon the study of thousands of slags made in the blast furnace under all conditions. In the Pittsburgh and Cleveland districts the ores were Lake Superior ores; in other districts they were Clinton ore and all kinds of ores that are used on merchant furnaces.

PLATE 9

Those who are thoroughly familiar with the blast furnace realize the countless types of slags that are possible, but the idea here is only to show the general types and the system underlying the formation of all slags. The writer will be more than repaid for the effort if this table only forms the foundation for further work in this field of research.

R. Burt Kernohan has retired as general superintendent of the Woodlawn plant of the Jones & Laughlin Steel Corporation, Pittsburgh, as well as relinquishing his position as a director. His retirement from active business is accompanied by the announcement he plans a world tour.

T. O. Westhafer, chief chemist of the coke plant of the Colorado Fuel & Iron Company, Denver, has been advanced to assistant superintendent of that department. James M. Scharf, assistant chief chemist, succeeds Mr. Westhafer.

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SHEET AND TIN PLATE

Pickling of Iron and Steel; A Bibliography

1—General and Miscellaneous. 2—Machines and Equipment. 3—Pickling in Acid Solutions. 4—Pickling in Salt Solutions. 5—Electrolytic Pickling. 6—Inhibitors and Accelerators. 7—Effect of Pickling. 8—Recovery of Spent Liquors.

Compiled by VICTOR S. POLANSKY*

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(Concluded in September)

Chromium—Its Uses and Its Alloys

This Article Is the First of a Series Dealing with the Uses of Chromium and Its Alloys—Its Valuable and Unique Properties Make It Almost Indispensable

By DR. WALTER M. MITCHELL*

PART I

CHROMIUM has been called the "master" metal—because of the remarkable properties which have made it indispensable as a constituent of certain classes of alloy steels, corrosion and heat resisting alloys. Whether it is wise to consider any metal a "master," or to say that it is indispensable, in these days of spectacular advances in metallurgy, is questionable, to say the least. Nevertheless, it is difficult to exaggerate the importance of a metal which, through its characteristic properties, probably affects a more diversified range of industrial activity than any of the others which are in common use, barring iron. If one were to decide which of the more common metals, again barring iron, we could least dispense with, chromium would stand very near the top of the list; and as its valuable and unique properties become better developed, and their application better understood, it must inevitably advance to still greater importance. We are acquainted with some of its useful properties; others, perhaps as well known, have not yet been converted to greatest service. It is the purpose of this paper to describe some of the applications of this interesting metal to industry, and it is hoped to stimulate still further study of its remarkable properties, both from the standpoint of metallurgical theory as well as practical use.

The subject is a very long one, and perusal of the extensive literature discloses many inconsistencies and contradictions which are difficult to bring into agreement by any reasonable explanation, and which are sometimes so contradictory as to create suspicion of the accuracy of the investigators, or at least of their methods. The metal chromium and its alloys, particularly the iron-chromium-carbon system, is of particular interest, but about which as yet comparatively little is definitely known. It affords a number of interesting fields for study, in which can be mentioned: The chemical phenomenon of "passivity," which has been investigated by Monnartz, and upon which the corrosion resistance of the metal and its alloys evidently depends; the formation of the extraordinarily hard and stable carbides at high temperatures, these attaining a hardness not reached by any other metallic substance, and which influence profoundly, in a way that is not yet clear, the hardness of the steels in which they occur; the ready chemical formation of at least three stable oxides of a metal which is apparently so unoxidizable; the great diminution of thermal conductivity imparted to steel by its presence in any considerable proportion, which necessitates increased care in heat treatment; and the remarkable retarding action which it appears to exert upon the atomic changes in iron. Certainly a promising field for the investigator, and one in which any research will probably have some ultimate practical application.

Discovery.

The metal chromium was discovered by the French chemist Vaquelin in 1797. He was led to the discovery when, in analyzing a red ore of lead from Siberia, now known to be a native chromate of lead, he found that the lead present was combined with a peculiar acid, which he recognized as the oxide of a new metal, evidently possessing unusual characteristics. He eventually separated the metal, classified it, determined most of its properties, in fact, so accurately, that the values in use today are only little different from those originally found by him. Vaquelin exhibited samples of the metal before the Académie des Sciences, and stated that it was white, very infusible, crystallized in needles, and that acids had very little effect on it. He believed that on account of its brittleness and infusibility it would find little use in the pure state, but that when larger sources had made the metal more obtainable its compounds might be of great use on account of the beautiful and durable pigments which could be produced from them. Vaquelin showed, further, that the emerald, a silicate of beryllium and aluminum, owed its brilliant green color to the presence of chromium.

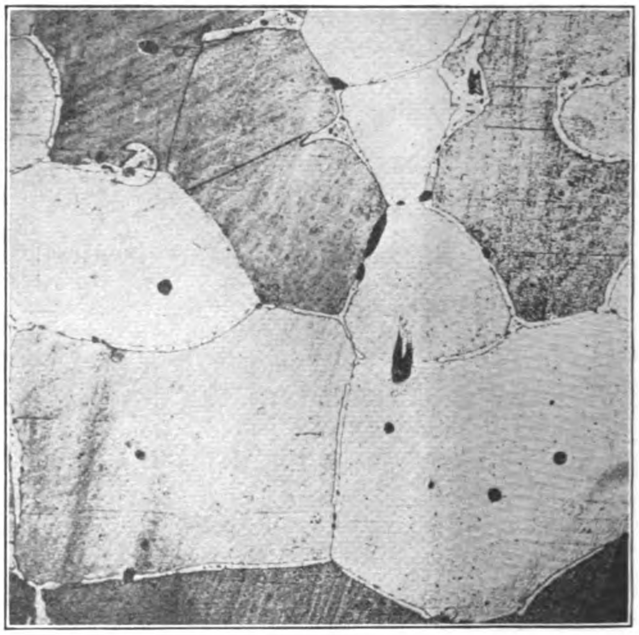

FIG. 1—Chromium metal, "carbon free" (?). The presence of carbon is indicated by the network of carbide along the grain boundaries. Thermit process. 100×. Etched in boiling 1-1 HCl. (Reduced about one-fourth from the original photomicrograph.)

The choice of a suitable name for the new metallic element occasioned some little discussion between Vaquelin and his friends; the latter suggested "chrome," from the Latin chroma—color, because of the different colors imparted by its compounds to various minerals, etc. But Vaquelin objected to the name "chrome," for he said the name did not suit the metal, since it had no color in itself. Evidently the advice of his friends prevailed, and the name "chrome" was thus first used, which, by the addition of the suffix "ium" applied to metallic elements, eventually was altered to "chromium." Although Vaquelin is correctly credited with the discovery of the metal, it should not be overlooked that it was also discovered independently by Klaproth at about the same time; but it is to Vaquelin that we owe acknowledgement for introducing this interesting metal to the world at large.

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Vaquelin was one of the many chemists from whose labors, crude as they now appear to us, we are today reaping so many benefits. His keen intuition enabled him to see far ahead when, in speaking of the new element, he said, "I would venture to say that if chemistry could only utilize but a few of the many objects that nature offers us, it would soon convert into useful application bodies which we now know only as vain curiosities." A prediction which, fortunately for us, has been verified many times. No doubt Vaquelin would be surprised if he could see to what extent we are indebted to the hard brittle metal discovered by him for the remarkable properties of modern armor plate, projectiles and ordnance, heat and acid resisting alloys, tool and automobile steels, pigments for painters' use, chemical processes for dying fabrics, tanning leather, etc.

The Metal.

The metal chromium has an atomic weight of 52, a trifle less than that of iron (56); specific gravity of 6.92, about the same as that of zinc; and a melting point at about 2800 deg. F., practically the same as that of iron. It is a hard; as commercially pure, brittle; silvery to greyish white metal; capable of taking a high polish which tarnishes in the air very slowly. Similar to iron, its hardness is greatly increased by the presence of small quantities of carbon. It is not appreciably affected by exposure to the atmosphere, and is practically unoxidizable below the melting point, except for the formation of a slight surface coating which prevents further action; but when molten appears to oxidize rather rapidly. It is attacked by sulphuric acid, more so by hydrochloric acid, but becomes passive—is unattacked—by concentrated nitric acid, the dilute acid attacking it slightly.

Sources.

Chromium is found in the free state in nature only in occasional meteorites. It occurs in the native lead chromate—crocoite; and in the mineral chromite—an iron chromium oxide, which is the chief ore of the metal. Ceylonite, found in Western Australia, contains nearly 23 per cent of chromic oxide. In addition chromium forms the coloring matter of numerous minerals; thus, the green of the emerald is due to chromium, while serpentine, pennine, chromic mica or fuchsite, and possibly certain sapphires and garnets all owe their color to the presence of this metal. Chromite, the chief ore, is found in periodotite, serpentine, and to a lesser extent in other ultra basic rocks. It is a heavy, black to brown, lustrous mineral, much like magnetite in appearance, but is only slightly magnetic. Crystals are of rare occurrence, the mineral being found in grains through the rock, which are sometimes segregated into nodular masses of considerable size with a compact granular texture. Rocks of this kind, when subjected to weathering conditions, become hydrated and altered into serpentines, and for this reason most of the workable deposits of chromite are found in the serpentine rocks. Chromite is widely distributed over the earth's surface, in Rhodesia, Baluchistan, New Caledonia, Brazil, California, Quebec, and elsewhere; the New Caledonian and Rhodesian mines supplying three-fourths of the world's supply. According to reliable sources, imports and domestic sales in the United States totaled over 200,000 tons during 1923. Of the chromite mined, the largest proportion, about 40 per cent, is used for the production of ferro-chromium alloys; about 35 per cent is used as a refractory, while the balance is used for the manufacture of bichromates, chrome alums, etc., for use in various chemical industries.

Chemical Properties.

Chemically chromium belongs to the same group as molybdenum, tungsten, and uranium, all of which are characterized by their hardness and infusibility. Owing to its multiple valency, chromium forms a number of oxides. Of these, chromous oxide, CrO, and chromic oxide, Cr_2O_3, are definite basic forms, yielding with acids salts in which chomium is present in the divalent and trivalent states, forming the chromous and chromic salts. Chromic oxide may also combine with bases to form salts, the chromites. Chromic anhydride (chromium trioxide) CrO_3 is an acid anhydride forming with bases salts called chromates and bi- or di-chromates. It may be prepared by the decomposition of a chromate with sulphuric acid, and is a strong acid substance crystallizing in scarlet rhombic needles. It has powerful oxidizing qualities, and is used as an oxidizing agent in organic chemistry, and as a caustic in medicine. Other oxides have been prepared and are usually regarded as compounds of the basic and acid oxides, and are known as chromic chromates. With carbon, chromium forms a number of carbides which have a profound influence on the physical properties of the steels in which they are formed. These will be considered in detail in what follows:

Chromite.

Although the greatest part of the chromite mined is used for conversion into ferrochromium and other chromium alloys, a considerable proportion is used in furnace construction in the steel plant as a refractory material, for which purpose it is nearly ideal. Its melting point is just under 4000 deg. F., which is far above the highest working temperatures of either the open hearth or blast furnace; and in addition it has the unique advantage of being essentially neutral in character. Hence, as it has neither acid nor basic qualities, it may be used as a lining for furnaces of either type. Mixed with slag, both finely ground, it is regularly used as a cement to daub furnace ports and jambs, and to patch walls near the slag line. In the form of brick it is used as a dividing course to separate acid from basic bricks, and for bottoms of soaking pits because it is impervious to "pit cinder."

Metallic chromium may be obtained from the reduction of its oxides by various processes, either by heating with carbon, which yields a product containing considerable quantity of carbide, or with dry hydrogen under pressure. A more satisfactory method is the Thermit process, in which chromic oxide is mixed with finely divided aluminum, the chromic oxide being in excess and igniting the mixture. The result will be a fused mass of metallic chromium of considerable purity, 99.5 per cent chromium having been obtained. (Figs. 1 and 2.)

Technical Uses.

Chromium compounds, such as chromates and dichromates, are prepared directly from the ore by roasting with sodium carbonate, and afterwards leaching with water, preferably in an autoclave under considerable pressure. The chromium salt is thus extracted, leaving the iron behind as an insoluble residue. Perhaps the most important of the chromium salts from the technical standpoint is the dichromatic (or bichromate) of potassium, which crystallizes in the well known anhydrous crystals. It is used in the preparation of many of the chromium pigments, for the manufacture of safety matches, for the oxidation of anthracine to alizarine, and in the manufacture of analine violet. The double sulphates of chromium with sodium, potassium, or ammonium are of great industrial importance. These are known as chrome alums, and occur in the form of dark purple crystals making a reddish solution which turns green when heated, the original color returning after standing for some weeks.

Chromium compounds are used in large quantities in the dye industry, both as oxidizing agents in processes for the manufacture of the dyestuff, and as mordants, i. e., substances which combine chemically with the dyestuff employed, to fix the latter on the fabric. Chromium mordants are of first importance, since with the different dyestuffs they yield a considerable range of colors which are notable for their permanence. The most important are the sodium and potassium dichromates, above noted, which are more extensively used in wool dyeing than any other metallic salts. For mordanting cotton goods, chrome alum, chromium acetate, chromium fluoride, and various other double chromium chromates are used. Silks are not usually mordanted with chromium salts, but may be so treated if boiled in a solution of potassium dichromate and tartaric acid, but the process is not desirable as the fabric is somewhat injured during the process.

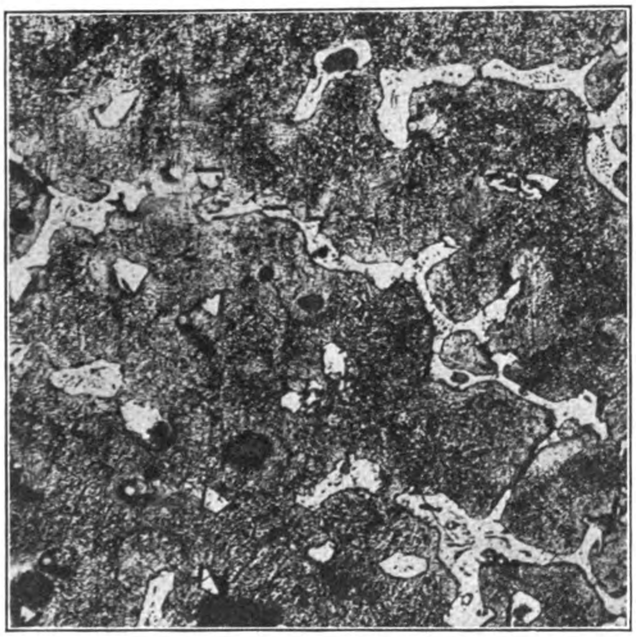


FIG. 2—Chromium metal by electric furnace. Lot analysis: Carbon .26 per cent, chromium 97.15 per cent. 150 ×. Etched in boiling 1-1 HCl. (Reduced about one-fourth from original photomicrograph.)

The salts of chromium have a peculiar hardening action upon gelatine and similar bodies, several applications of the chromium compounds depending upon this property. The "carbon" or "autotype" process in photography is based upon the fact that gelatine containing potassium dichromate becomes insoluble under the action of light. Paper is coated with a solution of gelatine containing potassium dichromate and a pigment of the desired color; this is exposed under a negative in the usual way. In those portions acted upon by light the dichromate is reduced, the gelatine holding the pigment becoming insoluble, while the unacted upon portions are dissolved with hot water. In this way photographs may be produced in any desired color, depending upon the pigment, which are of great beauty and permanence.

Another application of the hardening action of chromium salts upon gelatine of great commercial importance is the process of chrome tanning, which was originally developed in the United States. Two processes are in use, the "two bath" process, which came into prominence in 1884 under Schultz patents, in which the skins are tumbled in a solution of potassium dichromate, then tumbled in a solution of common hypo acidified with hydrochloric acid; and the "one bath" process originated by Dennis in 1893, in which the skins are tanned directly in a bath of basic chromium chloride. The latter process seems to be generally preferred because of its simplicity, except for glazed kid leathers, for which the two bath process gives a product with more desirable qualities. At present the majority of the world's supply of light leathers is tanned by one or the other of the chromium processes. During the World War an enormous quantity of leather was chromium tanned on account of its superior wearing qualities as a material for army shoes. The tremendous rise of "chrome" tanning has been favored by the speed and comparative simplicity of the process and the superiority of the product—the vegetable tanning processes requiring a much longer time and more labor. The lighter leathers, such as glazed kid, ooze and suede leathers are practically all chrome tanned, while the heavier leathers are generally vegetable tanned.

It is interesting to note that chrome tanning, unlike vegetable tanning, is a reversible process. If a chrome tanned leather is soaked in a solution of a tartrate like rochelle salt, the hide returns to the untanned condition, which is not without advantage in the recovery of scraps, trimmings, etc., for the manufacture of gelatine and glues.

Chromium Pigments.

Owing to the varied and brilliant colors of the chromium compounds of other metals they are widely used as pigments in the paint industry. Probably the most important is lead chromate, better known as "chrome yellow" or Paris yellow, obtained by precipitation of a lead salt with potassium dichromate. Produced in the presence of an alkali, a basic lead chromate of brilliant red color is obtained, known as "chrome red" or Persian red, Chinese red, etc. Mixtures of the two in various proportions produce a series of orange pigments known as "chrome oranges." The lead chromates all possess good covering powers

and brightness of color, but blacken under the influence of hydrogen sulphide. Chrome yellows, by mixture with Prussian blue, form greens known as Brunswick greens, which are useful and cheap pigments, but not as stable as the zinc greens. Chromic oxide, prepared by the oxidation of metallic chromium, or by ignition of various chromates, is a green pigment of great permanence, known under the names of "chrome green" and "ultramarine green." It is used for coloring porcelain, glassware, etc., as a pigment in oil or water color painting, and for coloring the printing inks used for bonds and banknotes. It is not affected by chlorine or sulphur gases and will stand heat. Zinc chromate, also known as "zinc yellow" or buttercup yellow, is a beautiful stable pigment produced by the action of neutral zinc sulphate upon potassium dichromate. Although not equal to chrome yellow in covering power or body, it has the advantage of not blackening with exposure to sulphides. It is largely used for mixing with Prussian blue to form a series of brilliant green pigments of wide usage, known as the "zinc greens." Basic chromium borate, known as Guignet's green, is the most permanent green pigment known, being unattacked by light, boiling alkalis, or by acids in the cold. The chromium yellow and green pigments are the most widely used of all such colored pigments.

(To be Continued)

A new experimental iron blast furnace, which embodies all the best features determined by observation of the performance of other furnaces constructed by Interior Department specialists, has been completed and blown in at the Minneapolis experiment station of the Bureau of Mines. The new experimental furnace is larger than the one constructed by the Bureau of Mines at Minneapolis last year, which was the first successful experimental blast furnace in the history of metallurgy. It is expected that metallurgical studies made possible by the construction of the new blast furnace will reveal valuable information relative to the production of spiegeliron from manganiferous iron ores, which cannot be smelted under present practice. Since the United States has tremendous reserves of these manganiferous iron ores, the problem of their successful smelting is one of great importance to the iron industry.

The present furnace, which was erected in cooperation with the University of Minnesota, is 36 inches in diameter at the hearth and 30 feet high. The first run lasted 10 days. Air was supplied to the furnace at the rate of about 600 cubic feet per minute, consuming approximately 8 tons of coke per day. From 15 to 20 tons of spiegeliron of varying manganese content was produced during the experiments. Several hundred gas samples were taken from the interior of the furnace shaft by means of water-cooled sample tubes.

The most striking feature of the furnace experiment in contrast with previous ones lies in the fact that a rather complete survey of the composition of the gas stream in the furnace shaft was possible. By introducing water-cooled sample tubes through various test-holes, it was possible to cover completely six planes. As early as 1839 Bunsen determined the composition of the gas in the blast furnace at various elevations from the tuyere to the stock line. His results have been duplicated in a dozen or more investigations. In all this research samples were taken from only one point in each horizontal plane. During the thirty-fourth and thirty-fifth runs with the Bureau of Mines furnace over 1,000 gas samples were taken at five elevations in the furnace shaft. These samples, however, all lay along a single diameter of the furnace section. The necessity of sampling over a complete section has long been recognized, but the difficulty of obtaining such samples in practice has heretofore not been overcome.

A considerable number of samples of raw materials, slag, and metal, taken during the run, await analyzing. A study of the analyses of these samples, as well as the samples of gas removed from the charge column within the furnace, should throw considerable light upon the mechanism of the gas reactions taking place within the blast furnace shaft and should result in the obtaining of much valuable information relative to the production of spiegeleisen from manganiferous iron ores.

The following is a list of papers that will be offered for discussion at the meeting of the British Iron and Steel Institute, September 4 and 5:

L. Aitchison and G. R. Woodvine: "Changes of Volume of Steels During Heat Treatment."

C. Benedicks and V. Christiansen: "Investigations on the Herbert Pendulum Hardness Tester."

E. D. Campbell and G. W. Whitney: "The Effect of Changes in Total Carbon and in the Condition of Carbides on the Specific Resistance and on Some Magnetic Properties of Steel."

C. A. Edwards: "Pickling: The Action of Acid on Iron and Steel, and the Diffusion of Hydrogen Through the Metal."

J. Newton Friend and W. E. Thorneycroft: "Examination of Iron from Konarak."

M. A. Grossman and E. C. Bain: "On the Nature of High-Speed Steel."

Axel Hultgren: "Improvements in the Brinell Test on Hardened Steel, including a New Method of Producing Hard Steel Balls."

F. C. Thompson and W. E. W. Millington: "The Effect of Free Surfaces on the Plastic Deformation of Certain Metals."

The United Alloy Steel Corporation, Canton, Ohio, will commence the immediate erection of a new sintering plant at its local mills, for which arrangements recently have been perfected. The plant will be of the well-known Dwight & Llloyd type, and will have a rated capacity of 250 tons of sinter daily from blast furnace dus. The company is said to be arranging for other betterments at its mills in connection with the new installation.

The Chateaugay Ore & Iron Company, Lyon Mountain, N. Y., has arranged for the installation of a new mill at its properties, to be equipped with magnetic separators. Other improvements will also be made at the works to provide for considerable increased production, as well as the installation of considerable auxiliary operating equipment.

Checking Up Losses in the Foundry

By **L. C. BREED**

THE reduction in loss resulting from waste of time and material is something which manufacturers are constantly seeking to accomplish. In case of most large companies the processes of production are periodically checked up. Notwithstanding this, there is loss which varies from large to small proportions in different industries which probably could be further reduced.

The president of a large company which is engaged in the manufacture of a great variety of iron, steel and brass products, recently stated: "In the making of thousands of tons of castings every month, there is, of course, a large waste. About 55 per cent of our malleable iron melts, for example, produce acceptable castings. Five per cent of melt is in defective castings, and more than 38 per cent of the total is in gates and sprues which are of no use except for remelting. After the good castings go through the machine for threading and finishing, another 5 per cent, on the average, must be discarded for various reasons, such as faulty machine work, air holes not detected at first inspection, breaks, etc."

It is likely that some other manufacturer would naturally inquire, "Why is this the case and why the 'large waste' to which the head of the company in question refers, cannot be cut down?"

It is proper to mention that the company referred to might be termed a manufacturer of specialties, and that they comprise a vast variety of quite small metal products. It is conducted on the "open shop" plan, and the company for a long time has sought to develop, train and create skilled workers among its employes. It uses machine made metal patterns in the foundry department. A percentage of the product is gray cast iron.

To secure the least possible waste in the foundry, one must necessarily begin with the melting of the iron, and the proper metal for the castings under consideration. By proper metal is meant not only metal of the correct chemical analysis, but metal properly mixed and melted and, therefore, correct in all respects for the castings which are to be poured. Then the various steps to the turning out of the finished product must be studied. Is the melting equipment as it should be to give hot, clean iron, or is the metal oxidized in the melting due to faulty management of the furnace? (In the case in question, the cupola process is employed.)

Is the sand correct for the castings to be made? The question of suitable molding sand, including mixing, cutting up and tempering, are important factors. With machine molding and patterns properly placed on the plate, do the flasks fit the pins on the plate as they should, or are they too loose, thereby causing mismatching? Gates and sprues are of course a necessary evil, and in the making of malleable iron the percentage of gates to castings is larger than in gray iron practice due to the shrink heads necessary to take care of the greater shrinkage in malleable iron. Again, when the malleable castings are small, the weight of the castings might be even more than the weight of the gate and sprue. The problem of gating is a serious one and losses in some cases might be traced to improper gating. If cores are used, and there are few foundries where it is not the case, losses can be traced due to faulty core mixtures, insufficient baking, hard cores, etc. Of importance in case of malleable castings, is the anneal.

Further causes of waste arise from the breaking of sand molds, either in clamping of parts of flask, by jarring sand into molds, or by cutting away of sand, by flowing metal into molds, by air pockets in castings and by cold "shuts"—points where metal meets metal flowing from different directions and arriving at point of contact too cold to fuse together. Through having a large amount of metal in sprues and gates, many times it will stay hot enough to flow readily without cold shuts. The worker, of course, is handicapped by the castings being out of sight.

In commenting on this instance of waste, one foundry man said he would venture to attribute it mainly to the fact that this company's product comprises a large number of small items. Its catalogue enumerates more than 23,000, when different sizes of the same commodities, different materials and different shapes are considered. Another reason that he names which, in his opinion, might affect the output of acceptable castings, was the company's policy of maintaining the open shop principle, and relying upon training a considerable proportion of its molders. This question might be debated: How large a proportion of over 100 men, who are employed in working in the malleable and cast iron shops, could be classed as skilled men? If because of unskilled molders there are larger gates than otherwise would be the case, metal would flow too freely into the molds. Furthermore, in operating to as nearly as possible full capacity output, a correspondingly large percentage of skilled workers is required.

Defective castings can only be remelted with a certain percentage of new iron. The money loss in case of malleable castings is greater than gray iron castings, and still more in case of steel castings.

Rigidity of inspection to meet a high fixed standard of quality in production is also a factor to be considered.

In the case in question, as the plant is situated in a metropolitan district, the labor turnover is greater than in smaller places, because of the facility of getting other employment. Again, the output of a foundry is affected by weather conditions. All employes are aware that the human element must be taken into account. In some instances the management offers the services of an optometrist and furnishes glasses to employes that are found to need them.

Reasonable discipline, esprit de corps, and morale are things which count for efficiency and consequently should be promoted.

The Northern New York Utilities Incorporated have been considering the installation of new equipment for sometime, and have just lately placed a contract with The U. G. I. Contracting Company for a complete 8-ft. set, together with operating floor for installation at their Rome, N. Y. plant.

CURRENT REVIEW

Lubrication in the Steel Industry

THE blast furnace, the Bessemer converter, the open hearth furnace and the rolling mill were the solution to our problems of maximum production with low cost and a minimum of labor. With this development, chemistry of iron and steel became a concrete science, to prove that by formulation of alloys with such elements as carbon, nickel chormium, vanadium and manganese, all manner of variable degrees of hardness, ductility and strength could be attained.

Chemistry and the ingenuity of the metallurgist, however, can determine only the nature of the product. They cannot govern the rate of production of the mechanical equipment involved because they have practically no control over that nemesis of mechanics—friction. Therefore, the science of lubrication must be reckoned with. In fact, lubrication is the key to efficiency and production in the steel plant. The intensive operation demanded calls for a minimum of friction and uniformity of bearing temperatures in the face of the most discouraging operating conditions. Hot water, acid fumes, salt, dirt, dust, etc., are examples of the objectional factors confronting the lubricating engineer. Take a concrete example: Air compressor and blowing engine lubrication at best is a ticklish proposition; but a small amount of dirt or a short period of operation on the wrong compressor oil may give rise to dangerous conditions or often fires in the air lines; perhaps even explosions or ruptures will result. Can the steel man close down his blast furnace or his open hearth when these occur? He cannot, for if he did, the workings of perhaps the whole plant might be disrupted. So he fights the fire or makes his repairs on the run—or better still, uses a preventative in the form of lubricants which he can be reasonably sure will function properly and relieve him of as much worry as possible.

Numerous other examples could be cited wherein the importance of good lubrication is the outstanding feature. It is better, however, to reserve them for further discussion wherever they fit in. Suffice it to say, the details of wrought iron and steel mill lubrication are of vital interest to us all. An industry which consumes approximately 60,000,000 tons of iron ore per year evidently is based upon the last word in productive efficiency. In other words, the steel man has appreciated the value of scientific lubrication and lubricating engineering service.

Lubrication of Blast Furnace Equipment.

Blast furnace operation involves the use of considerable mechanical apparatus. For example, there are the huge steam reciprocating or turbo-blowing engines which furnish the necessary low pressure blasts of air to the hot-blast stoves for pre-heating prior to delivery to the blast furnaces; the charging equipment which includes the wire ropes and bearings of the charging lorries and skip hoists, with their respective driving engines or motors, the slag cranes, the steam or hydraulic clay guns, the ladle cars and any miscellaeous gearing installed.

While the range of equipment is varied, the lubricating problems are not numerous. The blast furnace generates high heats and these are naturally radiated to their surroundings quite considerably. It is perfectly possible, however, to locate much of the necessary mechanical equipment either permanently or otherwise, so that it will be both free from this heat and also not subject to excessive dirt or dust. Take the case of blower steam cylinders for example: If they are lubricated with a good grade of cylinder oil which has been compounded and refined to meet the requirements of steam and operating conditions, perfect satisfaction should be attained. Bearings in turn can be grouped into two classifications:

1. As involving automatic lubricators, or
2. Exposed, hand-oiled conditions.

Steam engine, pump, turbo-blower, and electric motor bearings are largely oiled by some automatic system of lubrication. Inasmuch as they are usually enclosed systems and not subjected to external heat, they should give little or no trouble. Exposed, hand-oiled bearings as are found on skip buckets and transfer cars, etc., receive rougher service, and dust, dirt, and rain are always detrimental factors. Such bearings have high clearances, however, and operate at low speeds and pressures, therefore, a rough lubricant such as black oil is found to serve very well.

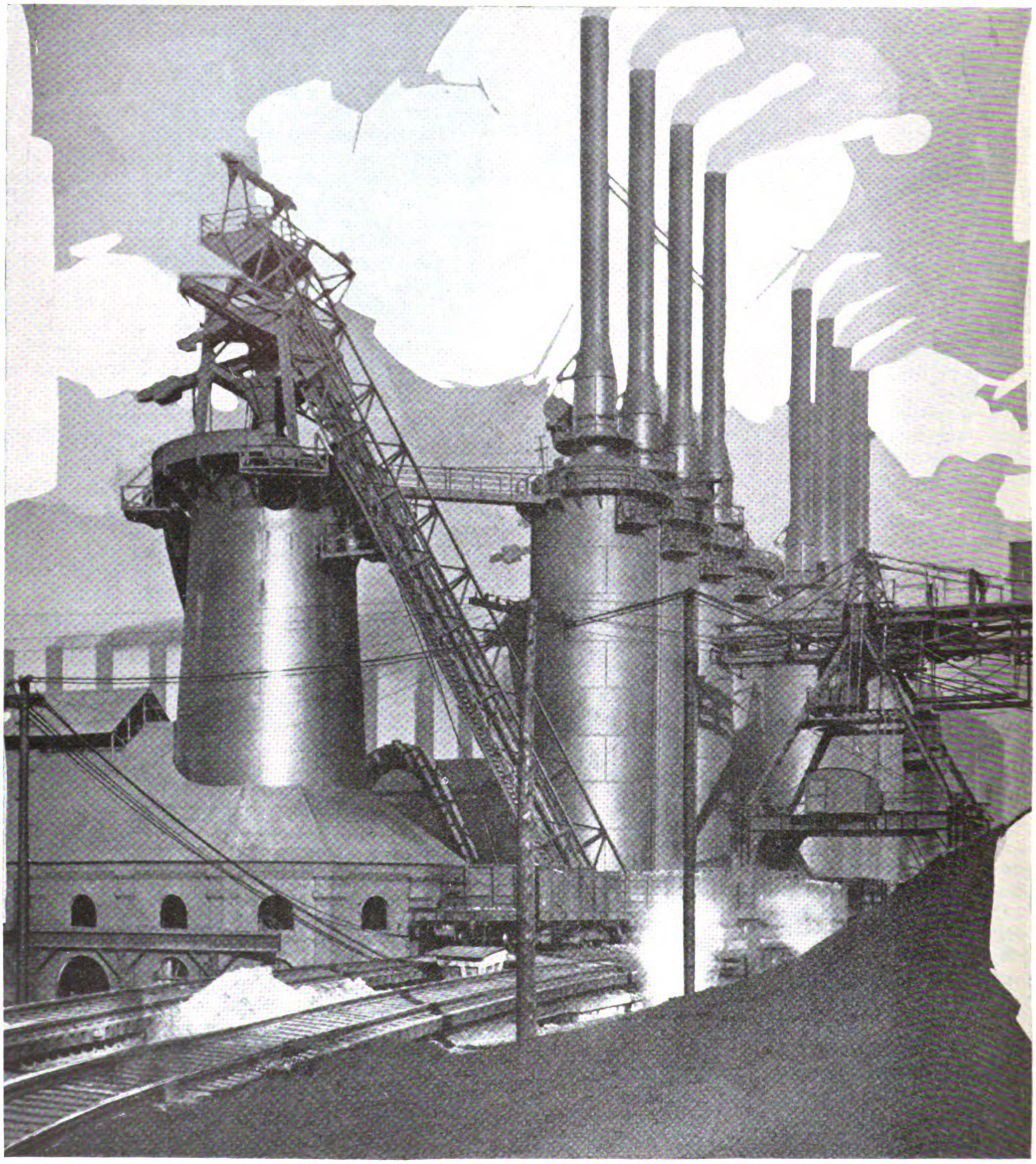
Gears and wire rope operate under similar conditions to skip car journal bearings, though at perhaps higher working presures. Therefore, a lubricant must be used which will not drip from their surfaces, which will penetrate to the core of the ropes, and which will adhere tenaciously to the gear teeth in an even film. Usually a straight mineral gear and rope compound of from 1000 to 2000 seconds viscosity Saybolt at 210 deg. F. will satisfy these requirements.

Air tub lubrication is exceedingly important due to the fact that pressure must be kept on the lines to the blast furnaces and Bessemer converts, etc., at all times. Therefore, cleaning is practically impossible, and the blowing cylinder lubricant must be so refined as to give rise to minimum carbonaceous accumulations in the air system as far as possible. Furthermore, every care should be observed to insure against feeding oil in excessive quantities to the air cylinders. In fact the right kind of oil will lubricate most satisfactorily when a minimum amount is fed to the cylinders. Excess never improves lubrication and only leads to objectionable oil deposits. The subject of air compressor lubrication and the effects of deposits were treated in considerable detail in Lubrication for March, 1924. Air tub pressures in the steel plant are usually low (in the neighborhood of 15 to 20 pounds), and temperatures will therefore never run much above 300 deg. F.

Blast furnace devices require careful attention to lubrication, for bearing and gear lubricants must withstand heat, pressure, dust and contamination by flying sparks. A straight mineral lubricant of from 1000 to 5,000 seconds viscosity Saybolt at 210 deg. F., according to weather and temperature conditions has been found best suited for this service. Bearings are usually hand lubricated with the exception of ring-oiled motor bearings; to meet the rough conditions involved black oil is generally used. Motor bearings, however, require a good grade of medium viscosity engine oil.

Bessemer Converters.

The fierce heat adjacent to the Bessemer converter naturally gives rise to considerable skepticism when it comes to lubrication. In fact, in the vernacular,



Correct lubrication is one of the important blast furnace problems.

"no can do!" has been the contention of not a few steel workers. But the converter has to operate, and be free to swing readily when charging or pouring is done, therefore the operating mechanism which comprises a pair of hydraulic plungers with suitable racks and pinions adjacent to the trunnions, must work with the least possible friction, otherwise the power consumption and time of turning might be rapidly increased. These gear mechanisms as well as the plungers are subject to very high conducted heat. Therefore the lubricant must be heat resisting to the highest degree. A straight mineral product of high viscosity has been found to meet the converter's requirements satisfactorily, due to its adhesive characteristics.

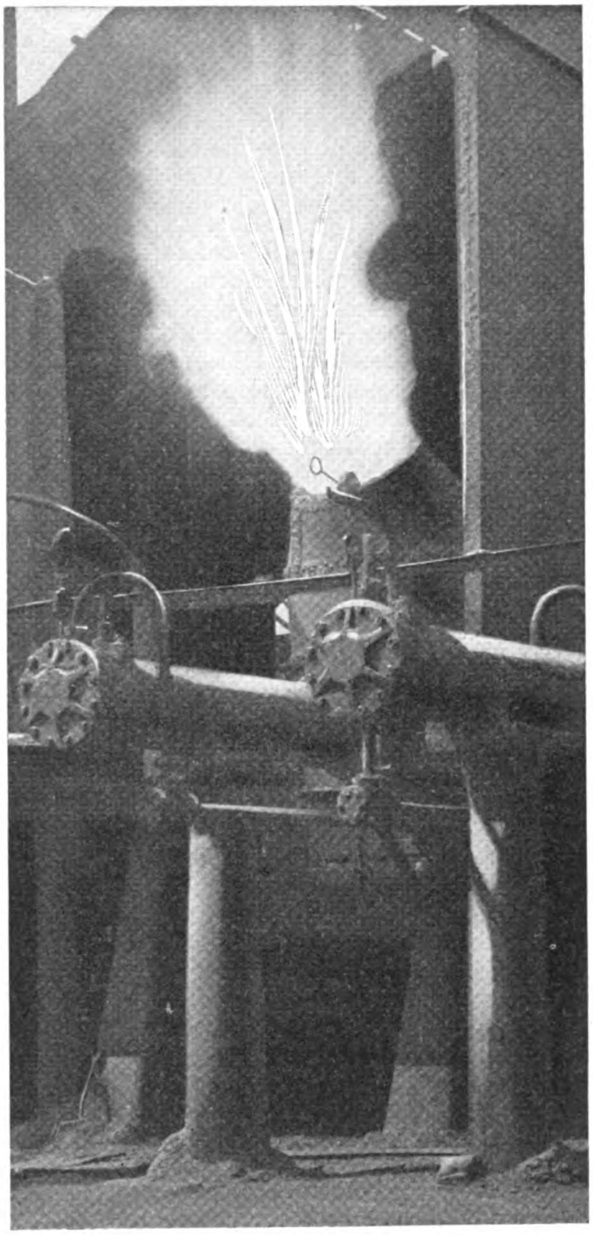
The blast for the blowing of Bessemer converters may be supplied by either horizontal or vertical steam blowers or turbo-blowers. These normally are located in engine rooms apart from the converters, and their lubrication, involving circulating oiling systems or mechanical force feed lubricators, is similar to that of any power plant unit, with no serious problems to worry about. See Lubrication for November, 1923, and March, 1924.

From the converters the steel is poured into a ladle which is usually carried by a steel crane capable of swinging on a vertical axis, for transfer to the ingot moulds. Cranes of this type are gear-operated. The predominance of heat, slag and steel dust naturally imposes the same severe requirements upon the lubricant as elsewhere in this part of the plant; as a result lubrication of gears and bearings often become quite a serious problem. If the gear compound as recommended for converter gears is used, with a good black oil for bearings and journals, many of the lubricating difficulties will be eliminated. In other words, the lubricant must resist heat and contamination with foreign impurities.

Ingot and ladle cars may be equipped with either plain journal boxes and brasses, or roller bearings. The latter are coming into quite extensive usage due to their savings in oiling labor, inspection and lubricants. While it might seem that such bearings would be subjected to considerable heat, we must remember that inasmuch as they are practically always in the open air, radiation can occur unhampered. As a result, such bearings, even before the ingots have solidified, will be comfortable to the touch. Hot metal, slag, dust, dirt and variable loads are usually the more important factors which must be considered. Especially are the former detrimental to plain journal bearings of the railway type because of the rough service and careless handling which is prevalent. In fact journal box covers either ajar, open or broken off, is a common occurrence. In the roller bearing of course, the housing is tight and no carelessness can so disarrange it as to expose the bearing or lubricant to the detrimental action of hot iron, slag, dust, dirt or water.

Open Hearth.

In the open hearth plant there is relatively little machinery requiring lubrication except the charging cranes, overhead traveling cranes, strippers, and operating mechanisms for raising and lowering the charging doors. In general, all equipment in this part of the plant which must be lubricated will be electrically operated. The overhead traveling cranes which serve for the handling of metal ladles are the most important hoisting devices involved; their uniqueness lies in their high rating, some runing up to 200 tons capacity. All have at least two separate hoists, the smaller or auxiliary being oftentimes as powerful as in the average crane found on other work. As in the Bessemer plant, heat and contamination are the chief detriments to which the lubricants are subject. The cables, gears, bearings, hoists and trolleys of all these mechanisms are periodically exposed to the extreme heat of molten metal and hot gases which arise from the boiling steel during tapping. This is particularly applicable to the cables holding the hooks which raise the ladles. As a result, lubricants which are not specially refined will tend to dry up and lose their effectiveness rapidly.



Heat, dust and weight must be overcome.

In certain plants where induced draft fans are installed to force the hot gases from the open hearth through a series of waste heat boilers, the lubrication of the bearings of these fans will often become difficult due to the heat from the hot gases which is conducted by the shaft to the bearing. These fans are usually motor driven, being equipped with water-cooled, ring-oiled bearings. To properly meet the heat conditions and afford the necessary lubrication, a relatively high viscosity engine oil, or even, in some cases, a steam refined cylinder stock must be used.

Electric Furnace.

The usual mechanisms which will require lubrication in the electric furnace are the rack and gear teeth, the bearings of the operating motor and connecting rod and any other accessory journals involved. In general, heat conditions will not be quite as severe, nor will these mechanisms be subject to as dusty operation as elsewhere in the mill. Therefore the usual lubricants specified heretofore for similar mechanisms will function with perfect satisfaction, in fact, lasting longer and giving better service than when operating conditions and temperatures are more severe.

Conclusion.

Although we have but given a fleeting introduction into the smelting and refining branches of the steel industry, we feel that sufficient has been said to bring out the particularly important part which is played by lubrication. It is true, the average equipment is rough, and massive, and first glance would lead one to believe that lubrication was really but a trifle. But the operating mechanism of these massive units must be accurately designed and machined, since they are so inter-dependent upon one another. In effect, the principles of good machine-work must be incorporated in the steel mill as everywhere else in industry, if efficient production is to result.

—Lubrication for July.

General Electric Review for July

Six signed articles appear in the July issue of the General Electric Review, together with four unsigned articles. The cover is a photograph of Thomas A. Edison seated in the cab of the large C. M. & St. P. locomotive now on tour in the east, and the frontispiece shows a four-node, backward traveling wave in a thin disk model of a turbine wheel. The issue contains 71 reading pages.

"The Engineer's Place in Society," by Gerard Swope; 5 pages.

This article contains the substance of the first Aldred lecture delivered before the Massachusetts Institute of Technology. In it, the author talks about the position the engineer should occupy in society, emphasis being laid on the value of his training in the development of sound, analytical judgment.

"Detroit Operates New Three-Car Articulated Train," by A. C. Colby; 8 pages and 10 illustrations.

This electrically operated unit is the first of its kind in the world. Mr. Colby reviews the traffic situation in Detroit calling for its adoption, describing the train itself, together with what is expected of it.

"The Vacuum—There's Something In It", by Dr. W. R. Whitney; 10 pages and 11 illustrations.

The contents of this article were originally presented in an address before the American Association for the Advancement of Science, at Cincinnati, in December, 1923. Its purpose was both to inform and to encourage workers in other scientific fields by presenting a summary of the results of research in what might seem the most unpromising field of all—high vacuum.

"Switchboard Type Temperature Indicators," by D. M. Carswell; 5 pages and 10 illustrations.

Mr. Carswell in this article shows how, by the use of these indicators, the risk of inadvertent crowding of equipment is lessened. He states that these indicators provide an accurate and reliable means of keeping posted on machine temperatures, thus making overheating practically inexcusable.

"Studies of Electric Discharges in Gases at Low Pressures," by Dr. Irving Langmuir and Harold Mott-Smith, Jr.; 7 pages and 2 illustrations.

The theory of plane, cylindrical and spherical collectors, with retarding and accelerating fields, is presented in this, the first instalment of a series of articles. Subsequent sections will deal with typical experimental data with plane, cylindrical and spherical collectors, following which there will be a general discussion of these results and their interpretation.

"The Protection of Steam Turbin Disk Wheels from Axial Vibration," by Wilfred Campbell; 26 pages and 44 illustrations.

This is Part II of a series of three articles covering a full and detailed description of the work done in studying various forms of vibration and waves which may exist in steam turbine disk wheels. This instalment gives a general discussion of the nature and theory of vibration in turbine wheels and explains why it is necessary to rely on actual tests in addition to purely analytical methods to accomplish thorough protection of the factory product.

"Chicago, Wilwaukee & St. Paul Locomotive on Exhibit Tour"; 1 page and 1 illustration.

An account is given of the exhibition trip of one of the five, 265-ton, 3000 volt, d.c., gearless locomotives owned by this railroad .

"Coffin Awards"; 2 pages.

Two articles tell the story of the recent awards made by the Charles A. Coffin Foundation, one to the Public Service Company of Northern Illinois for "the greatest contribution towards increasing the advantages of the use of electric light and power for the convenience and well-being of the public and the benefit of the industry," and the other award being made to eight college graduates in the form of fellowships to enable them to follow research work in college.

"Bibliographies"; 3 pages.

Three bibliographies are included in this issue, relating to the general subjects of X-rays and of metallurgy.

German Blast Furnace Patents for 1923

Specifications of patents granted in Germany in 1923 relating to the improvement of blast furnaces:

366906 — Rhein, Nassauische Bergwerks — und Hutten A. G. and Dr. Alfred Spieker in Stolberg.

Process for utilization of waste iron containing metal, lead, zinc, tin or enameled iron, being characterized by the fact that the waste iron is melted in the lead tempering bath, eventually with addition of leaden materials into a product which owing to its contents of iron and zinc is suitable for being treated in the blast furnace, whilst the other constituents of the waste iron are extracted out of the remaining products of the melting process.

366827 — Leonhard Treuheit, Elberfeld.

Process for generation of iron in the cupola furnace, whereby only slag containing iron is being treated. This process is characterized by the fact that the slag is reduced by means of carboniferous materials, such as powdered charcoal, being injected into the blast in a well known manner.

372934 — Deutsche Maschinenfabrik A. G., Duisburg.

Relating to an apparatus to cut off the conveyance of the charge consisting of finely grained or powdered material into the melting zone of blast furnaces. This invention being characterized by the fact that in case the pressure emanating from the furnace surpasses that by which the charge is conveyed to the melting zone, the equilibrium of pressure is restored automatically or the passing of the charge into the melting zone is cut off automatically.

374146 — Dr. Rudolf Fabinyi & Jeno, Kolozcwar.

Process for the production of poorly coaled iron out of its ores by reducing it by means of methan, being characterized by a temperature during the process of reduction varying from 700 to 1000 deg.

375165 — In addition to 354469, Vlucan Feuerungs A. G. Dusseldorf.

Process for improving the working of cupola furnaces and blast furnaces, being characterized by the fact that the water being injected along with air receives a larger quantity of oxygen.

380246 — Deutsche Maschinenfabrik A. G., Duisburg.

Device for the injection of finely grained or powdered materials into the melting zone of a blast furnace by means of a blower, being characterized by an airtight case containing the charge. Through this case passes the heated air which carries with it parts of the charge into the melting zone of the furnace.

381006 — Carl Flosseu, Dusseldorf.

Prices for the production of pig iron and steel, being characterized by an immediate connection of the low-shaft furnaces for the production of pig iron with the open hearth furnaces and basic converters for the production of steel in such a way that the gases escaping from the low-shaft furnace are conveyed into the open hearth furnace for heating purposes. The gases escaping from the open hearth furnace and the basic converters are used either apart or together with the gases escaping from the furnace for the preheating and prereduction of the ores.

382499 — Deutsche Maschinen fabrik A. G., Duisburg.

Device to cut off the conveyance of finely grained or powdered material into the melting zone of blast furnaces from a high level hopper through a vertically disposed pipe. This invention is characterized by the fact that the weight of the charge in the high level hopper acts on a mechanism fixed to the conveyer in such a way as to close the passage to the melting zone in case the passing of the charge into the high level hopper being interrupted and the weight of the hopper being diminished.

Iron Trade Review

Following are some of the more important news articles, market reviews and features of Iron Trade Review during June:

June 5.

Considerably more action is apparent in the pig iron market, many large users having placed important orders during the week. No. 2 foundry iron has settled to $20 to $21 valley. The effect of recent price reductions is apparent in Iron Trade Review's composite of 14 leading iron and steel products which this week is $40.84 as compared with $41.14 in the preceding week. The general market is back to the level of January, 1923. Plates, shapes and bars have eased off to 2.20c Pittsburgh, with concessions for preferred business. Plate prices in the east are around 2.00c, Pittsburgh. Production of pig iron in May was 2,631,248 tons, a loss of 594,859 tons from April. The number of furnaces in blast at the end of May was 188. Eighty-one stacks were put out during March and April.

The sheet and tin plate wage scale in plants having agreements with the Amalgamated association has been reaffirmed for another year, the Amalgamated withdrawing its demand for an increase of 25 per cent. Wage reductions in the Connellsville coke district in many instances to the 1917 basis are more general.

Leading business men and industrial managers of the St. Louis district are guests at a dinner tendered by Festus J. Wade, president of the Mercantile Trust Company, St. Louis, for the purpose of crystallizing St. Louis' possibilities as a coming iron and steel center.

The melting of 9 tons in a 3-ton electric furnace as carried out at the plant of the Dibert, Bancroft & Ross Company, Ltd., New Orleans, is described in this issue. Standardizing tool data sheets is described in an article by A. L. Evans, giving a number of approved forms.

The American Society of Mechanical Engineers at its spring meeting in Cleveland May 26-29, devoted attention to industrial preparedness, education and standardization.

June 12.

Iron Trade Review's composite of 14 leading iron and steel products is slightly lower this week, $40.06 as against $40.85 in the preceding week. No. 2 foundry iron is down to $19.50 valley. The pig iron market generally reveals lower price levels although there is not much change in steel. The steel corporation has eliminated price margins that have recently prevailed and in some instances is meeting the $4 per ton lower figure on blue annealed, black and galvanized sheets, following the lead of the independents. The American Radiator Company has closed for approximately 75,000 tons of pig iron. The Ford furnace at Detroit sold 20,000 tons of basic to a northern Ohio steel maker.

Production of steel ingots in May totaled 2,628,261 tons, or 705,274 tons less than in April, a reduction of 21.2 per cent. At the end of May the unfilled orders of the Steel corporation totaled 3,628,089 tons, the smallest since November, 1914. Iron Trade Review's European manager cables from London that the Belgians are flooding the British market with low price steel, 20,000 tons having been unloaded at Welsh ports. The government of India has adopted the report of the tariff board raising duties on steel and steel products, affecting American imports.

The steel corporation in a brief filed with the Federal Trade Commission analyzes the evidence presented in the Pittsburgh Plus case, denying that the basing point plan is illegal.

James A. Farrell, president of the Steel corporation, speaking at the 11th annual convention of the National Foreign Trade Council in Boston, states that he believes the business depression is near an end. He outlines America's problems in world commerce.

A description is given of the special optical instruments used by British steel makers in examining large forgings. The restoration of Belgian steel works is described by Gustave Trasenter, chairman of the Soc. An. d'Ougree-Marihaye.

The open-hearth steel capacity of the Inland Steel Company at its Indiana Harbor, Ind., works has been increased to the extent of four 100-ton furnaces which have just been completed and are described in this issue. The first of two articles is presented outlining the changes made in the federal income tax law and explaining its features, as written by a tax expert.

June 19.

Bookings by the steel corporation so far in June are several thousand tons in excess of the similar period in May and general activities of the iron and steel industry remain at 45 to 50 per cent of steel ingot capacity.

Further reductions are noted in pig iron prices and at the same time a great increase in sales. At Chicago where the price has been marked down $1 to $21.00, new orders amount to about 100,000 tons. Iron Trade Review's composite has declined from the 16th consecutive week, this week being $40.55.

An article in this issue analyzes the tendency with respect to wages in iron and steel and related lines. The Amalgamated association has withdrawn its demands for increases in wages for bar mill workers and the agreement the Amalgamated has had with representative bar mills has been reaffirmed for another year.

From Europe comes the information that German strikes have been settled and that steel mills are resuming operations on a much larger scale. The Micum, so-called, agreements for delieveries of coke from Germany to France have been extended. An article is presented in this issue on the rapid development of alloy steel as traced by Sir Robert Hadfield. The Hornsey process for the direct reduction of ore as now being developed in England, also is described in this issue.

June 26.

Recent buying movement in the pig iron market since June 1 has netted furnace operators 500,000 to 600,000 tons, principally for the third quarter. A sanitary ware manufacturer in the Pittsburgh district has in the last few days placed an order for 22,000 tons. Lower prices on pig iron are in evidence, No. 2 foundry in the valley being $19.00 and this also representing the market in several other important consuming centers. Iron Trade Review's composite this week is $40.37 compared with $40.55 in the week preceding. This is the lowest since December, 1922. An accumulation of orders has allowed the sheet mills in the valley to suddenly expand their operations from 15 to 41 per cent of capacity and a much better sentiment prevails in the market. There is very little interest in the market for semi-finished material. The tonnage placed in the structural steel market during the week was the largest in nine weeks. Awards for reinforcing bars were the best in over two months.

Final arguments are made to the Federal Trade Commission in the Pittsburgh Plus case and the next step in the proceedings is a decision by the commission. The iron ore bridge of the Pittsburgh & Conneaut Dock Company, subsidiary of the United States Steel Corporation, at Conneaut, was destroyed by a wind storm on June 20. The lower unloading bridge of the Ashtabula and Buffalo Dock Company at Ashtabula, identified with Pickands, Mather Company, also was destroyed. One of the steel corporation's ore bridges at Lorain, Ohio, was blown off the track and damaged. A survey of the British steel industry and its expansion is presented in a paper that was a feature of the meeting of the iron and steel section, Empire Mining and Metallurgical Congress, in London, June 3-6.

July 3.

Production of pig iron in June was at a daily average of 67,379 tons compared with 84,515 tons in May, while the total output for June was 2,021,377 tons, in contrast with 2,619,986 tons in May. The June production was at the lowest point since the coal strike in August 1922. The total loss of production since March has been 39.8 per cent. The loss of active furnaces since March is 109. 160 stacks were in operation on June 31.

In the same time there has been an increase in pig iron sales and the total for June has been estimated at more than 600,000 tons. The four selling interests with headquarters in Cleveland booked 340,000 tons in June. Iron Trade Review's composite of 14 leading iron and steel products has shown a decline for 18 consecutive weeks and now is 40.13 compared with 40.37 for the preceding week. Steel lines are quiet. Steel corporation is operating at about 53 per cent of ingot capacity.

The new malleable foundry of the Belle City Malleable Iron Company, Racine, Wis., which has a capacity double that of the former foundry and features some special handling equipment in its operation, is described in this issue.

Machine tool builders are endeavoring to apportion their cost figures over five year periods, and an article in this issue by Mr. H. R. Simonds, Boston correspondent, outlines methods followed by some of the leading manufacturers. This article presents six charts illustrating methods of averaging cost and other data pertaining to the business.

The American Society for Testing Materials, at its twenty-seventh annual meeting at Atlantic City, June 24-27, studies corrosion, heating, and electrical resistance properties. This issue contains a complete report of the meeting.

July. 10.

A seasonal lull has developed in most finished steel lines, although there is some indication of reviving interest. No change is noted in mill operations. Iron Trade Review's composite this week is 39.91, the same as the general composite for August, 1923. More stability is observed in the markets for pig iron, while the medium size foundries continue to close for fair size lots. Coke for spot shipment has been sold down to 2.75 in the Connellsville district, while contract tonnage is taken at $3. About 900 workmen, principally miners, employed by one of the leading coke producers, have gone on strike against return of the 1917 basis of wage payment.

Steel ingot production for the first half of 1924 was 18,635, 138 tons compared with 22,133,827 tons in the first half of 1923. Production in June fell 15.5 per cent when compared with May, and this brings the total loss from a high point in March to 40.89 per cent.

A cablegram from Iron Trade Review's European manager at London states that business in the European iron and steel markets is suffering from renewed political wrangling over the Dawes' reparation plans. A new index of business devised by Colonel L. P. Ayres, a Cleveland banker, was based on a record of blast furnace operation and Colonel Ayres' plan was fully described in this issue.

The Second International Exhibition of Foundry Equipment is opened at Birmingham, England, featuring an important display of modern mechanical devices.

An Iron Ore Myth

Either some one has been spoofing the St. Louis Globe-Democrat and the public in general, or that worthy newspaper is chaffing the rest of us. According to its leading editorial in a recent issue, there is a deposit of iron ore "in and near the Racoon Mountains, in northern Alabama," that in "three great blanket veins of high-content iron ore stretches over an area estimated at more than 1,500,000 acres," containing no less than 50,000,000,000 tons. "In other words," says the Globe-Democrat, "in one compact deposit, 400 miles from St. Louis, is twice as much iron ore as in all the other known deposits of the world. These Racoon Mountain ores are not to be confused with others that have enabled an important metallic industry to flourish in the vicinity of Birmingham, Ala." It continues: "The magnitude of the amazing deposit, almost undeveloped as yet, is known to technical specialists, but scarcely a whisper has reached the general public."

Since this startling news arrived, the entire staff of geological reporters and iron ore specialists have been searching painstakingly for this amazing deposit of ore, but without success. There are lots of raccoons, however, they all agree, with a good chance for something in the nature of a skin enterprise. "Wasn't it Muscle Shoals and its unlimited power resources that the Globe-Democrat was thinking of?" asked one. "The weather was hot, and a newspaper editor might easily get confused, with all this convention stuff to handle."

"The location given is somewhat hazy," replied one Alabama geologist who was asked. "It reminds me of a Cockney Englishman named Perkins whom my brother met in Algiers, and who ingenuously inquired if Charles 'knew his brother in America.' The place of abode of the Americanized Perkins was somewhat sketchily indicated as 'near Fullydulphiyah on Boston River,' the precise name being finally dug up and stated as 'Sarn Franchesko.' 'Raccoon Mountains' is about as accurately described, in respect to location, as was Perkins," he concluded.

Of all the news unearthed by these keen-scented sleuths in northern Alabama the bit that sounded most like 50 billion tons of ore was to the effect that, a year or so ago, a Chicago syndicate acquired (or so the rumor said) about 140,00 acres of mineral land, mainly coal and iron, and was to develop it with a $5,000,000 incorporation. Nothing has since been heard of the syndicate, however, and payments on some of the properties are long overdue.—Engineering and Mining Journal Press .editorial.

According to the recently issued Second Supplement to the Institute's Bibliographic Bulletin No. 1, copies of which may be had upon request, 1 book, 2 bulletins, 34 research reports, and 74 other scientific and technical papers were published during the calendar year 1923 by members of the Institute; 13 United States patents were also issued to industrial fellows. The total contributions to literature for the 12 years ended January 1, 1924, have been as follows: 11 books, 27 bulletins, 300 research reports, 387 other articles, and 246 United States patents.

The Institute is primarily an industrial experiment station, but the nature of its investigational procedure enables broad training of young scientists in research methods and in special subjects of technology. It also recognizes the need of fundamental scientific research as a background and source of stimulus for industrial research. It has funds which are devoted to the prosecution of investigations not suggested by industry, but planned within the Institute and directed towards the study of more fundamental problems than those usually investigated for direct industrial purposes. During the period covered by the Eleventh Annual Report, four members of the Institute were engaged in purely scientific research of this type. The needs of industry are so varied and numerous that its research men are constantly opening up promising fields for investigation along fundamental lines.

—Industrial and Engineering Chemistry.

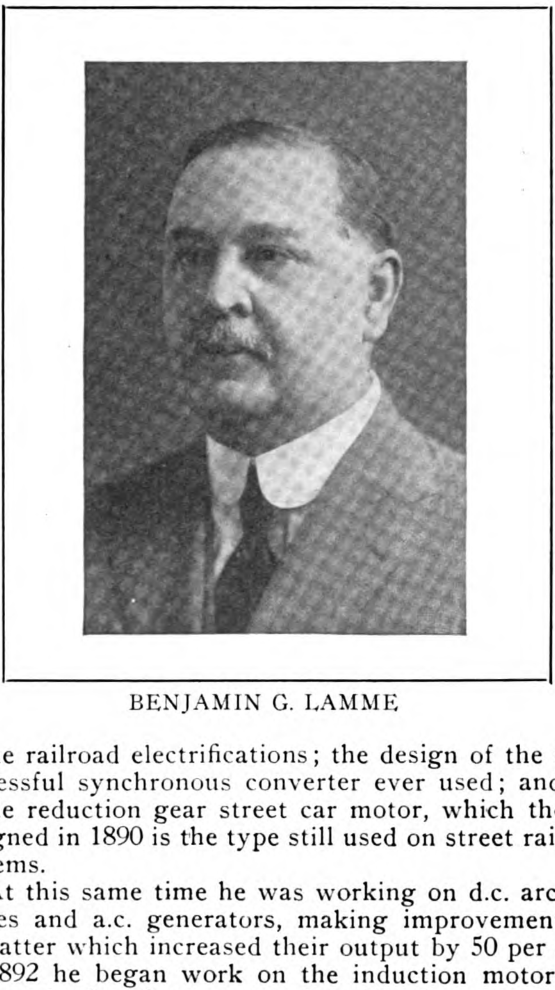
The American Rolling Mill Company have completed arrangements for rebuilding their "West" blast furnace at South Columbus, Ohio. The present furnace will be dismantled and a new mantle ring, furnace shell and downcomers erected. The top equipment and the McKee Revolving distributor at present on the furnace will be utilized and re-erected. Arthur G. McKee & Company, engineers and contractors, Cleveland, have been awarded the contract for the entire program.

The first unit of the 6-battery extension to the Carnegie Steel Company's by-product coke plant at Clairton, Pa., was put into operation on June 27. This extension comprises a total of 366 Koppers Becker type combination ovens arranged in six batteries of 61 oevns each, together with complete by-product and benzol recovery plants. This extension will have a capacity for carbonizing 8,500 tons of coal per day. The Clairton plant now consists of a total of 1,134 ovens having a carbonizing capacity of approximately 22,000 tons of coal per day, all of which have been designed and built by the Koppers Company.

BENJAMIN G. LAMME, Chief Engineer of the Westinghouse Electric and Manufacturing Company, and one of the world's leading electrical authorities, after a lingering illness of several months, died at his home, 230 Stratford Street, East Liberty, Pa.

George Westinghouse, with whom Mr. Lamme was closely associated until Mr. Westinghouse's death, had perfected the alternating current system, by which electricity could be transmitted over great distances economically. Mr. Lamme then perfected railway and industrial motors and synchronous converters to make this alternating current useful at any point, and thus the use of electricity was removed from small, restricted areas and its use made universal.

His most spectacular achievements were the designing of generating equipment for the World's Fair in Chicago in 1892; 5,000 hp. generators, a world's record at the time, when Niagara Falls was first harnessed for waterpower; generating and motor equipment for the first big railway electrification, that of the New York, New Haven & Hartford Railroad; the present day single-phase alternating current, high voltage railway system, which is responsible for most of the railroad electrifications; the design of the most successful synchronous converter ever used; and the single reduction gear street car motor, which though designed in 1890 is the type still used on street railway systems.


BENJAMIN G. LAMME

At this same time he was working on d.c. arc machines and a.c. generators, making improvements in the latter which increased their output by 50 per cent. In 1892 he began work on the induction motor and produced the first successful distributed winding motor of this type. In 1892 Mr. Westinghouse took the contract for lighting the World's Fair. Great polyphase generators had to be designed for this purpose and Mr. Lamme did the work. He also designed the synchronous converter, large induction motor and other machines which were exhibited at the fair. At this same time, he was designing railway generators whose performance was the boast of the Westinghouse Company.

Then came the Niagara Falls power development, for which Mr. Westinghouse took the contract for the electrical apparatus. The huge umbrella type generators rated at 5000 hp. each, were calculated to a nicety by Mr. Lamme, and the machines were a great success.

About the year 1895 Mr. Lamme conceived the idea that led to the development of the well-known type — C — induction motor with the squirrel cage rotor. Engineers still marvel at the type C motors and also at Mr. Lamme's paper on induction motors, which is a recognized classic.

His great work on the synchronous converter, however, he regarded as one of his greatest achievements. For years, he fought the battle for the synchronous converter almost single-handed. He won out, as usual, and this is now the accepted machinery for converting alternating into d.c.

Then came his conception of the single phase a.c. railway system. He had long held the belief that the success of heavy electric railroading lay in the use of a high voltage a.c. on a single overhead trolley. He felt that the simplicity and advantage of this system with its simple sub-stations containing nothing but lowering transformers and with no attendants required, were so great that it must come. The main difficulty lay in finding suitable ways and means for utilizing the single phase a.c. After several attempts, Mr. Lamme succeeded in designing a series commutator type of motor with suitable characteristics, which he described along with the system of power distribution in his famous paper before the American Institute of Electrical Engineers.

The paper created a furore of excitement all over the civilized world and soon every electrical manufacturer was working madly on the problems, and a dozen types of motors were on the market. Mr. Lamme never pinned his faith solely to the commutator type motor, although that is the type that has been most used. He maintained that one of the great advantages of the system lay in the fact that several different types of equipment could be used, all running under the same trolley.

Mr. Lamme has received the highest honors from the American Institute of Elecerical Engineers, in being elected one of the two members from that body on the Naval Consulting Board during the War and being chairman of the inventions committee on that board. In 1919, he was also awarded the Edison Medal by the American Institute of Electrical Engineers for his engineering achievements. All of these were in consequence of his work and ability as an engineer — he was in competition with engineers only. When the Board of Trustees of Ohio State University awarded him the Joseph Sullivant Medal, it was a recognition of the value of his work to the world.

Designer of many kinds of electrical apparatus, Mr. Lamme's declarations and writings on electrical and mechanical engineers. His greatness as an outstanding electrical engineer can best be judged by the eagerness with which engineers always sought his opinion and discussion.

Mr. Lamme was a member of the American Institute of Electrical Engineers and the Engineers Club of New York.

The POWER PLANT

Mechanical Stokers

A Profitable Investment for Small Boilers?

By **ROBERT JUNE***

IN Detroit there is a manufacturer of steel products with a plant covering several acres of ground. This manufacturer heats his plant with high pressure steam generated in three 72-in. x 18-ft. tubular boilers, 150 hp. each. Ever since the plant was built several years ago these boilers have been hand fired during the heating season of about seven months per year. In 1922 an oil burning system was installed on one of the boilers and oil purchased at about 6 cents per gallon, but the cost of operation under this method was found so excessive that this plan was soon discarded and hand firing was again resorted to for the balance of the heating season. Coal cost him at that time about $7.00 per ton in the bin and the evaporation averaged 6½ lbs. to 7 lbs. water per pound of run-of-mine coal.

This is one of a series of articles by Robert June, who is well qualified to write on this subject. The articles are written from the view of the managing executive and deal with the dollars and cents end of power plant operation and maintenance. Succeeding articles deal with such live topics as safe and efficient boiler operation and maintenance, what management should know about coal and ash handling equipment, steam piping, efficient turbine operation, etc. The series is timely and should prove of value to our readers.

It was necessary to operate all three boilers almost continuously to carry the load which meant that boilers had to be cleaned on Sundays or holidays. This also meant that the manufacturer was at all times running a risk of being short of steam if a boiler had to be taken off the line and repaired. The stack serving the boilers smoked badly which was serious in view of the plant location on the principal boulevard of the city.

In the summer of 1923 a large building was added to the heating load. It was decided to investigate the possibilities of stokers. Both hand fired stokers and mechanically operated stokers were considered, but the order was finally placed last fall for mechanically operated single retort underfeeds.

Operating conditions during the past winter with mechanical stokers installed have been very different from those of the past. With the exception of two weeks in January during which zero weather prevailed, two boilers carried the load all winter The plant engineer states that their evaporation instead of being 6½ to 7 lbs. as in the past has been increased to 8½ or 9 lbs. Instead of burning run-of-mine coal at $7.00 per ton this winter they burned nut pea and slack which costs $4.60 per ton in the bin.

The operating force are all boosters for mechanical stokers and the management is very thoroughly sold on the idea that mechanical stokers are a profitable investment on even small boilers operated only part time, because they have proven to their own satisfaction that in their own case mechanical stokers pay for themselves in a very short period of time.

What Happened When They Enlarged a Small Ohio Plant Sixty Per Cent.

Naturally you would think that the addition of 42,000 sq. ft. of floor space (constituting a 60 per cent increase in area) in a manufacturing plant with its high ceilings and large window space, would inevitably increase very materially the coal consumption. This was not the case, however, at this plant because they put in a small underfeed stoker at the same time they enlarged the building. For seven years prior to the installation of the stoker, the coal consumption had averaged 652 tons a year. On this same basis a 60 per cent increase in the building space would have increased the coal consumption to an average of 1040

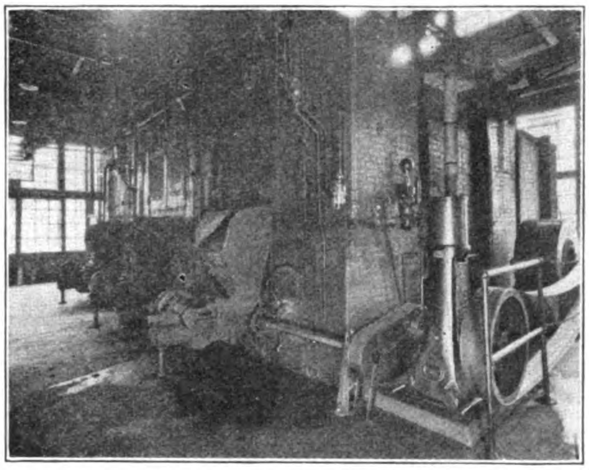


FIG. 1—*The installation of stokers in this plant increased evaporation from an average of 6½ to an average of 8½ lbs. of water per pound of coal Instead of burning run of mine coal at $7.00 per ton they now burn nut, pea and slack at $4.60 per ton.*

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*Robert June Engineering Management Organization, Detroit, Mich. Copyright 1924.

tons yearly. As a matter of fact, the first year the stoker was installed the coal consumption was reduced to 540 tons—a clear saving of 500 tons as compared to the coal consumption based on former practice, and a net saving of 100 tons as compared to the average for the preceding seven years.

Another Ohio Manufacturer Cuts Costs.

The power plant of another small Ohio manufacturer had been operated for a number of years by a very efficient force, which in five years succeeded in reducing the fuel consumption from approximately 12 tons per 10 hour day to 10 tons per 10 hour day under the same load conditions.

Three years ago the old equipment was discarded and small water tube boilers of the same make installed. These were equipped with single retort underfeed stokers. This installation is in daily operation and the fuel consumption has now been reduced to six tons per day. A saving of 40 per cent in fuel has thus been secured.

Uniform steam pressure is now maintained and recent tests under every day operating conditions show an overall efficiency of boiler and stoker better than 75 per cent.

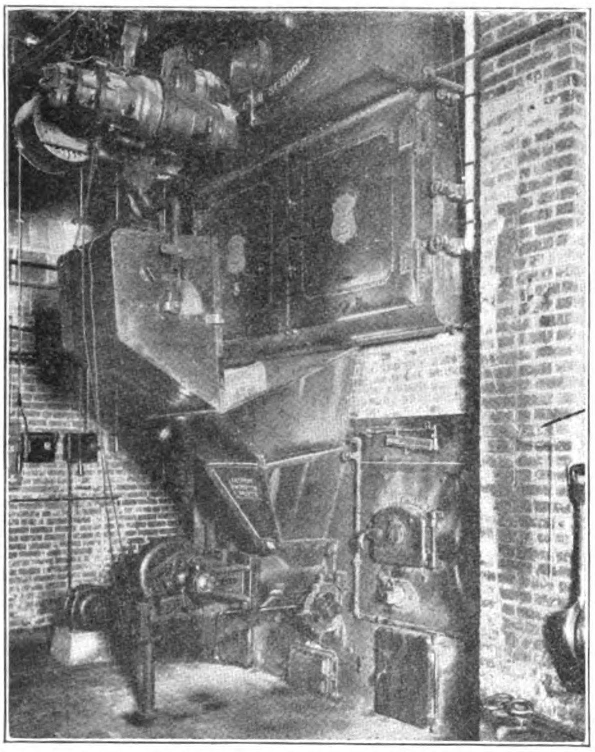

FIG. 2—*The installation of a mechanical stoker under this boiler resulted in a net saving of 100 tons of coal per year, although the load was increased 60 per cent. The actual saving, taking the larger load into account, figured out to 500 tons per year.*

Saved 118 Tons of Coal a Month With a 30 Per Cent Increase in Load.

At another steel plant they had been operating their small power plant for 15 years and had been making approximately 96,000 units of electricity per month. About two years ago a small underfeed stoker was installed in the plant as a test and the management found by the operation of this single stoker that they saved 118 tons of coal during the first month of operation. During this same period of time they produced 127,000 units of electricity or an increase of 31,000 units over any previous month. The management was so pleased with this showing that it contracted for the immediate installation of two additional small stokers to equip its other boilers.

What to Expect from a Stoker Installation.

All of the above experiences relate to very small boilers in what are literally one and two man boiler plants. They are typical of the experience of hundreds of operators of very small plants who have installed mechanical stokers of various makes.

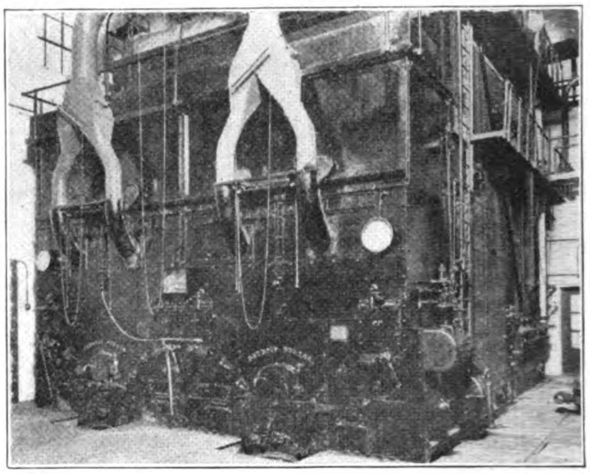

FIG. 3—*Mechanical stokers are saving five tons of coal a day in this plant besides providing an efficient means of burning refuse.*

The operator of the small plant often finds it difficult to believe that a stoker will be a profitable investment for him. He does not see how he can save labor, as he perhaps has only one man in the boiler room as the matter stands, and he is not convinced that the other savings such as the saving in fuel, which is the most prominent factor which occurs to him, will warrant the expenditure. When he turns to the stoker manufacturer, his skepticism is not removed by the refusal of the stoker manufacturer to make him a guarantee of savings in fuel as compared to results he is now obtaining by hand firing.

Now a word as to the stoker manufacturer and the proposed guarantee. The only means of determining that such a guarantee has been made is by an elaborate evaporation test and the maintenance of close records of hand firing operations for some period prior to the installation of the stokers. The cost of such a test may amount to $400 or $500 if carried out in all detail to a proper conclusion and there is considerable uncertainty as to the reliability of records available. The situation then works out to where the prospective user of the stoker really has to buy it on faith to a certain extent.

If the mechanical stoker can be installed without expensive alterations to the plant such as would be involved in raising the boiler, increasing the stack or digging an expensive basement, the expenditures for the stoker will prove to be one of the best paying investments the purchaser ever made. It may even prove a good investment if considerable alterations are required in the boiler room but in such event a very careful study should be made of the entire situation.

The mechanical stoker has demonstrated in actual practice that its installation under even very small boilers, results in the following economies:

1. Fuel Saving: Saves eight to 12 per cent of coal—a result due to more nearly complete combustion. Hand-fired plants average 50 to 55 per cent overall boiler efficiency, whereas stoker fired boilers average 70 to 75 per cent and over. See Table I for test on a 120 hp. return tubular boiler.

2. Labor Saving: Saves approximately 50 per cent of boiler room labor depending upon plant conditions.

3. Cheaper Coal: Burns lower grades of fuel than is possible with hand firing. Savings thus effected may be of such magnitude as to pay for the cost of the stokers each year.

4. Increases Boiler Capacity: Stoker fired boilers may be continuously driven to much higher ratings than hand-fired boilers. This assures an adequate supply of steam at all times. It may permit shutting down one or more boilers, or, where demands are heavy, obviate the necessity of buying additional boilers.

5. Smokeless Operation: With stokers smokeless operation at all loads is secured through practically complete combustion.

6. Eliminates Human Factor: Man's efforts constantly vary in intensity and skill. A fireman doing first class work in the morning will be less attentive in the afternoon when he is tired. His efficiency moves up and down from hour to hour and from day to day. Presently he leaves the plant and a new man takes his place. Contrast this condition with one where stokers are employed. Steady, even production follows as a matter of course. Steam pressure remains constant—the same amount of coal produces the same amount of steam week in and week out—boiler efficiency is uniform, dependability has replaced instability.

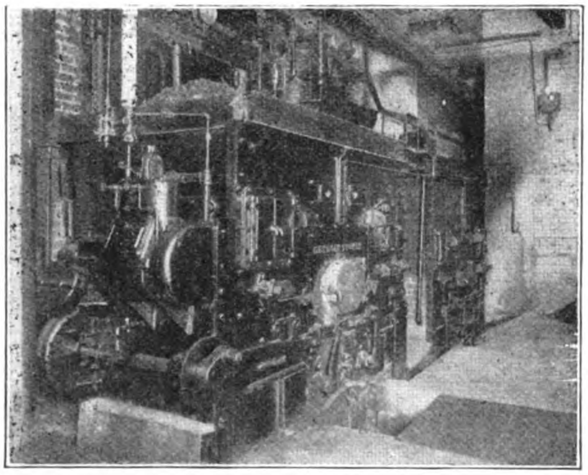

FIG. 4—*It pays to equip very small boilers. Two Detroit "V" type stokers on 125-hp. boilers.*

7. Meets Emergencies: Suddenly varying loads on boilers of medium size, particularly where the number of steam generators in a plant is limited, offer a real firing problem. Hand firing, because of its slowness and the uncertainties of the human element, does not offer a satisfactory solution. Rapid production of steam to meet heavy requirements calls for the use of mechanical stokers.

The Story of Two Plants.

Listed above are certain economic advantages resulting from the installation of mechanical stokers. The dollars and cents value of these savings may be calculated in advance, and to this extent the worth of the stoker is tangible. There are other advantages, equally important, but not readily calculable because, to some extent, they are intangible.

The point may be illustrated by reference to two power plants of approximately equal size and capacity. One of them had hand-fired furnaces, and, further, the bad conditions of this type of firing had a psychological effect on those working in the boiler room. The place was in a generally ill-kept and unsatisfactory condition. The other plant was equipped with mechanical stokers, and, perhaps, because the attainment of efficiency in combustion stimulated the firemen to better work all around, the boiler room was in first class condition. The first plant was using half again as much coal as the second, and because of the bad conditions in the boiler room the cost of steam generation was actually twice the cost of generation in the second plant.

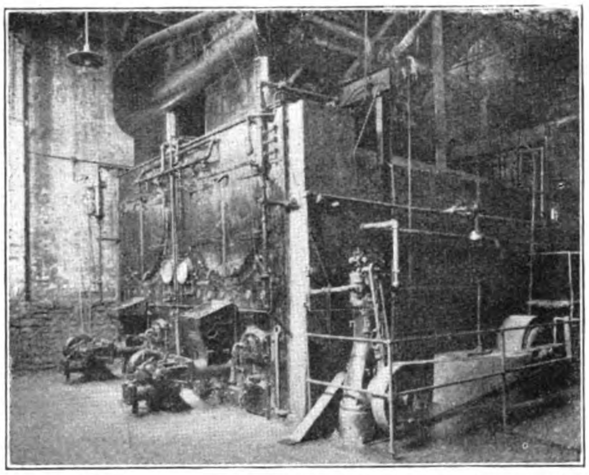

FIG. 5—*Two Detroit underfeed stokers* on GB *in. by* 18 *ft. return tubular boilers.*

A study of the psychology of the fireman, who labors under adverse conditions is replete with interest. Too often he works in a dimly lighted boiler room with equipment so inefficient that any incentive he may have toward improving conditions becomes buried.

Where careless management prevails, coal soon comes to mean nothing to him but a black substance of unlimited supply. When the storage space gets empty, coal cars or motor trucks refill it. The boss who pays the bill makes no demands regarding the saving of fuel. The management's one demand is that steam should be kept up, and therefore, why should he, the fireman, be concerned about anything but the pressure gauge?

This was the condition existing in the first boiler room. When the management finally took up the problem of reducing the cost of steam generation, they found the firemen ready and willing to co-operate. When it was proposed to install stokers the management found the men actually welcoming the idea, although they realized that some changes would have to be made in the number of men working in the boiler room. After the stoker installation had been completed, it was found that a cheaper grade of fuel than had previously been used could be burned, and that, due to the uniformity with which the stoker fed the fuel, the proper proportion of air for combustion, the absence of large amounts of excess air, etc., it was possible to maintain a uniform boiler efficiency of approximately 70 per cent, whereas 55 to 60 per cent had been the rule before, and the same amount of steam could be generated with considerably less coal.

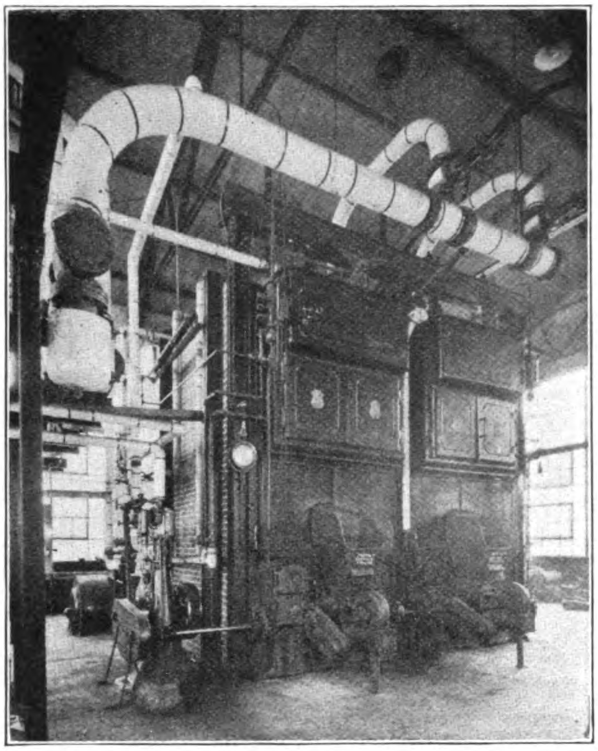

FIG. 6—*Detroit underfeed stokers on two* 155-*hp. water tube boilers.*

With the installation of the stokers, a transformation took place in the boiler room. The firemen began to display a hearty interest in their work, with the result that esprit de corps of the operators and the whole appearance of the boiler room was changed. As a result, the cost of producing steam in the plant was reduced something like 50 per cent, bringing it down to the cost in the second plant.

TABLE I — TEST ON DETROIT "V"-TYPE STOKER

Rec. Feed—Bar Drive Under One H.R.T. Boiler—

66 In. x 18 Ft. 0 In.

	Hp. of boiler (builders' rating)	120
	Size of stoker	4 ft. 11 in. x 5 ft. 3 in.
	Grate surface — projected	27 sq. ft.
	Kind of fuel	Kenawa gas coal slack
	Duration of trial — hours	8
	Total Quantities	
1.	Duration of trial — hours	8
2.	Weight of coal as fired—lbs.	3576
3.	Per cent of moisture in coal	5.38
4.	Total weight of dry coal fired—lbs.	3384
5.	Total ash and refuse — lbs.	463
6.	Per cent of ash and refuse in dry coal	13.7
7.	Total weight of water fed to boiler—lbs.	32,508
8.	Factor of evaporation	1.083
9.	Equivalent water fed to boiler from and at 212 deg. — lbs.	35,206
	Hourly Quantities	
10.	Dry coal fired per hour — lbs.	423
11.	Dry coal per sq. ft. of grate per hour—lbs.	15.66
12.	Water evaporated per hour—lbs.	4063.5
13.	Equivalent water per hour from and at 212 deg. — lbs.	4400.7
	Average Pressure and Temperature	
14.	Steam pressure by gauge—lbs.	99.6
15.	Temperature of feed water — deg. F.	170.3
16.	Temperature of flue gas — deg. F.	507
17.	Force of draft in breeching	...
18.	Force of draft over fire—inches	.10
	Horse Power	
19.	Horse power developed	127.5
20.	Builders rated hp.	120
21.	Percentage of builders rating developed	106.3
	Economic Results	
22.	Water evaporated per pound of coal as fired—lbs.	9.09
23.	Equivalent evaporation from and at 212 deg. per pound of coal as fired—lbs.	9.84
24.	Equivalent evaporation from and at 212 deg. per pound of dry coal—lbs.	10.40
25.	Equivalent evaporation from and at 212 deg. per pound of combustible — lbs.	12.05
	Coal Analysis	
	Moisture — per cent	5.38
	Volatile carbon	...
	Fixed carbon	...
	Ash — per cent	10.00
	Btu. of coal as fired	13,088
	Btu. per pound of dry coal	13,833
	Efficiency	
	Efficiency of boiler, including stoker based on dry coal — per cent	72.6

Air Infiltration—Enemy of Boiler Efficiency

By I. S. PIETERS*

Air infiltration is one of the largest, and at the same time the most insideous causes of fuel waste. It may exist for a long time—indefinitely, in fact—without being suspected, unless an Orsat, a CO_2 recorder, a pyrometer or similar apparatus is used to search it out by exploring the passes and for passages.

This seepage of air from the outside to the inside of the furnace other than through the fuel bed, (usually called "excess air") takes place through porous bricks, through fissures and cracks in the bricks themselves, through the joints between bricks and between brickwork and metal and through warped and leaky inspection and cleaning doors. When it enters the furnace, it lowers the temperature of combustion; when it enters higher up it lowers the temperature of the gases sweeping the heating surfaces; and, if of sufficient magnitude may cause trouble by causing local cooling and contraction. In each case it wastes fuel. By lowering the temperature difference it reduces the draft when increased draft is needed. In any case, it overloads the stack so that the combustion rate is retarded, the draft may be inadequate and the evaporation rate curtailed.

Finding Air Infiltration.

Air infiltration is readily discovered by analyzing the flue gas from different sections of the furnace, boiler passes and breeching. The use of a pyrometer in the various passes also shows when excess air is seeping in and the source or sources of the leakage can be ascertained.

It is a simple matter to locate the more serious source of air leak; it needs no special instruments but only a little experience and perserverence. One way is to fire up, using a good thick fuel bed, so as to obtain dense smoke. Then close up the stack damper while leaving the ash pit damper open. Smoke will be forced out through the cracks and openings through which air is normally drawn in.

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*Jointless Fire Brick Company, Chicago, Ill.

Another way is to open the stack damper wide and produce an intense draft in the furnace. Pass a lighted candle over the brickwork, around joints where brick and metal meet and other places where cracks and leaks might be supposed to exist. The flame of the candle will be drawn toward the cracks by the negative known—the furnace or draft. Mark them with chalk and fix them as soon as possible.

How to Eliminate It.

Although the one-piece, impervious, jointless, monolihtic lining shown in the illustration is the easiest and most permenent way of preventing or stopping air infiltration, still other precautions are often taken, especially where induced draft is employed. The application of a steel casing around the boiler setting is one way. The use of wire net covered with asbestos and boiler setting compound or paint is another; with a number of variations. Each aims to seal up the brickwork and cracks from the outside and so stop the seepage of air into the furnace. The monolithic lining seals them from the inside.

The monolithic, jointless or one-piece lining will do more than any other one thing to prevent air infiltration for a given draft or negative pressure in the furnace. The monolithic lining eliminates all brick joints on the furnace side of the boiler setting. It constitutes a thick inside lining, keyed to the bricks, through which air cannot pass. It is impervious to air and by closing up the inside of the furnace entirely, keeps the heat in and the cold air out.

That this is true was proved by a test made by the Jointless Fire Brick Company, manufacturers of Plibrico Furnace Lining.

The chart reproduced here shows the relative heat conductivity of an ordinary laid-up fire brick wall (A) and a wall constructed of jointless Plibrico Furnace Lining, (B) as determined by boiler test runs. Tests show the superior insulating quality of the monolithic wall, which means a saving of fuel.

In making the tests, half of the back wall was lined with fire brick — the other half with the jointless lining. In a recent test, the furnace temperature ranged from 2895 to 3010 deg. F. The temperature back of the fire brick wall ranged from 1660 to 2020 deg. F.—behind the monolithic wall from 1365 to 1770 deg. F.

It is wise to use this monolithic lining to cut heat loss, for with this saving there come other advantages. It lasts two to four times as long as fire brick, life of four and even five and six years being not uncommon. It is easily installed by inexperienced persons—no highly paid bricklayers are needed.

The Use of X-Ray in Foundry Practice

By L. C. BREED

In the field of human endeavor, modern science has been found to render efficient service, and especially in the direction of the elimination of conjecture regarding "how to proceed to get satisfactory results." For example, the physician, in case of an accident to a person, by the use of X-Ray knows what has happened to a limb and how to treat it. In foundry practice, it now is possible to penetrate steel upwards of three inches in thickness. By the use of X-Ray, defects which are not at all apparent can be located and an imperfect casting can be rejected if necessary. But of far more value is the fact that it now is possible to stress the importance of seeking to discover the cause from which the defects arise.

It is, of course, admitted that these comments more particularly apply to expensive jobs, or to those where strength is a factor of much importance. It readily will be seen that where a casting costing several thousand dollars is rejected, the cost of the next one is greatly enhanced. As a result it may be said that it is problematical, in some instances, to determine in advance whether or not, in filling a contract, the job will be found to be profitable.

While it is possible to make use of X-Ray in some lines of work, it is not practicable in case of rails for the reason that defects of a "stringy" kind are too fine to be shown on the film on account of lack of intensity in the power of the X-Ray.

There is another phase of this matter to be considered, namely, if it is possible for the manufacturer to discover defects by the use of X-Ray, by the same token it also is possible for the purchaser to do this, or have it done for him independently of the manufacturer.

Million Dollar Electrical Equipment Order

The Carnegie Steel Company has recently placed with the Westinghouse Electric & Manufacturing Company orders amounting to over a million dollars for electrical equipment to be used in a new structural mill which will be erected by the steel company at its Homestead works. The electrical equipment ordered includes a 15,000-kw. turbine-generator; three 1,000-kw., 500-rpm., 3-phase, 25-cycle, 6,600-volt a.c. motor-generators and their switchboards; and complete equipment for one 44-inch reversing blooming mill, one 36-inch reversing roughing mill and one 28-32-inch finishing mill.

The equipment for the 44-inch reversing blooming mill consists of a 15,000-hp. reversing motor, a flywheel motor-generator set of two 3,000-kw. generators driven by a 5,000-hp. a.c. motor, and auxiliaries, switchboards and control for the mill. The 36-inch roughing mill equipment consists of a 10,000-hp, reversing motor, a flywheel motor-generator set of two 2,100-kw. generators driven by a 5,000-hp. a.c. motor, and switchboards, auxiliaries and control for the mill. The 28-32-inch finishing mill has a flywheel weighing 125,000 pounds and is driven by a 6,000-hp. direct connected, a.c., wound rotor motor with suitable control.

The building of the new structural mill consists one-half of an extensive building program planned by the Carnegie Steel Company at its Homestead Works for the replacement of old and obsolete equipment. Three of the oldest structural mills will be dismantled and replaced by two large mills of the latest design, the obsolete steam driving equipment being replaced by electric drive throughout.

Trade Notes and Publications

Sells Butt Weld Plant

Assets of the Cleveland Steel Tube Company's plant located on a 21-acre site paralleling the Erie railroad at 14th Street, Cleveland, have been sold to Morris G. Songer of Pittsburgh and associates. The purchasers' plan to organize the Union Tube Company under the laws of Ohio with a capitalization of $300,000. The plant was built in 1920 by the International Steel Tube Company for the manufacture of butt weld pipe and some of the equipment was installed. Owing to financial difficulties the International company failed. The holdings were purchased by Cleveland interests and the name changed to the Cleveland Steel Tube Company. The new owners will purchase sufficient equipment to round out one butt weld mill, and if present plans materialize they expect to place the mill in operation about October 15.

The American Sheet & Tin Plate Company made an unusual non-accident record in April. In eight of its plants not one accident occurred from which any time was lost.

According to newspaper reports, W. R. Wilson, president of the Crow's Nest Pass Coal Company, is connected with a company which proposes to establish a steel industry at Fernie, B. C., to cost $5,000,000. Coal, iron and all other raw materials can be secured from this part of British Columbia.

The Robert June Engineering Management Corporation of Detroit, which handles industrial advertising, sales development and engineering management, is moving from its present address at 8938 Linwood Avenue to 8835 Linwood Avenue. This move, which is the second in six month, more than doubles the office space and is made in order to provide better facilities for service to the organization's clients, and to provide more room for the organization's research and data files and engineering library.

The Conveyors Corporation of America, 326 W. Madison St., Chicago, has published a new booklet describing their American cast iron storage tank, which is a sectional tank for the storage of all dry loose, bulky material, such as ashes, coal and gravel, etc. The booklet is illustrated with diagrams and half-tones of tanks in use. It contains table of weights, measures and capacities. Copies of this new booklet may be had on application to the Conveyors Corporation of America.

A series of catalogues, bound into book form, covering practically the entire range of production of Manganese Steel Castings, is the result of unremitting endeavors by the American Manganese Steel Co. With the expenditure of much effort and considerable money, they have collected and arranged a large and interesting body of information and data regarding both the general subject of the manufacture and application of Manganese Steel, and, specifically, the varied types of castings and equipment they sell, with their uses. The book contains much valuable information not ordinarily convenient and is profusely illustrated.

A new catalog by the National Carbon Company is being distributed. This catalog represents a departure from their usual procedure in that the size has been materially increased, other carbon products included, and the technical side of brush operation emphasized to a greater extent than ever before. To facilitate the changing of obsolete pages or the insertion of additional ones, the catalog is made up of loose leaf sheets.

In addition to carbon and metal graphite brushes which form the main part of this catalog, the other carbon products manufactured by this company are explained. These include a great variety of products, among which are the following: Battery electrodes, blue printing carbons, calcined coke, carbon tubes and rods, contacts, granular carbon, lightning arresters, projector carbons, photographic and photo engraving carbons, rheostat plates, searchlight carbons, transmitter back plates, transmitter diaphragms, turbine packing rings, transmitter discs (rough), transmitter discs (mounted and polished), welding carbons, welding carbon rods, welding carbon plates, welding carbon paste, miscellaneous carbon specialties not otherwise classified.

One of the most interesting new publications issued recently is the book "Better Street Lighting with Greater Safety." This describes the Kuhlman Series Multiple Street Lighting Systems, and can be obtained by writing the Kuhlman Electric Co. at Bay City, Mich. The Kuhlman Electric Co. is the originator of the series-multiple transformer and much instructive data is incorporated in this book.

Will Build Big Passenger Liner

Contracts for the construction of the largest electrically propelled sea-going passenger liner have recently been given the Cramp Shipbuilding Company by the American-Hawaiian Steamship Company, Inc. Turbine-electric drive was selected by the owner in preference to direct Diesel engine or geared turbine.

The turbine-electric propulsion equipment, consisting of two Curtis turbines with a total of 20,000 hp., will be supplied from water tube boilers burning oil. The turbines will drive two a.c. generators of 7,700 kw. each, which in turn will drive two G. E. synchronous motors of 10,000 hp., direct connected to the propeller shafts.

The completed vessel will cost about $5,000,000 and will operate between San Francisco and Honolulu. Accommodations will be provided for 600 first-class passengers and 250 members of the crew. Two years will be required before this first large electrically propelled passenger vessel will be complete.

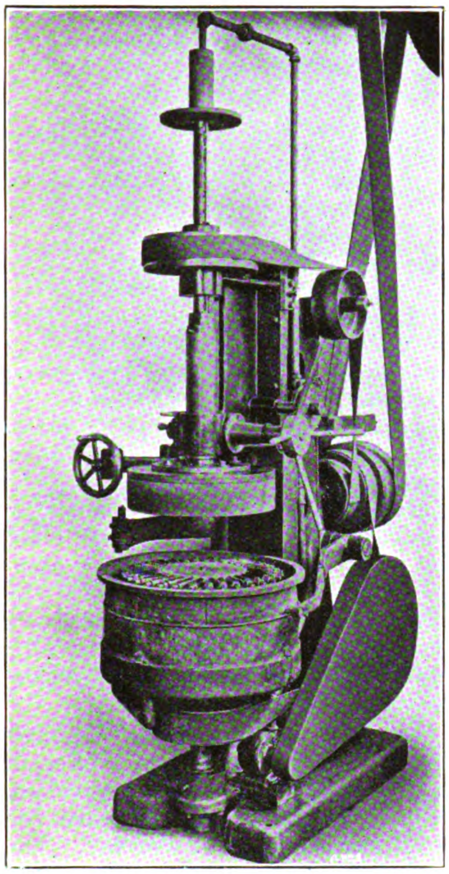
Berlin, June 26, 1924.

On the occasion of the projectedAmerica travel of the L Z 126, we are going to publish in a few weeks the following book: Director Dr. Durr, Friedhichshafen, 25 Years Zeppelin Construction. Price G. M. 6

The book, richly illustrated, will be printed on the best art print paper. It is going to be a fine jubilee souvenir (edition) in honor of Dr. Durr, who devoted 25 years to the study and construction of Zeppelins. The book will contain a tempera portrait of the count Zeppelin and will be richly illustrated; it will also contain one plate on the best art print paper. It will be a remarkable feature on the book market and to judge by the many subscriptions, the edition will soon be sold. The right of translation into the English language together with the right of selling the English translation in the United States, Canada and Mexico will be sold. Cuts will be furnished without special charges.

WITH THE EQUIPMENT MANUFACTURERS

The Mirra Lapping Machine



The Mirra Lapping Machine now being manufactured by the Reed-Prentice Company, provides for a new process of lapping cylindrical work. It is now being used for the lapping of piston pins for a large number of automobile and stationary engines. It is applicable to all of the standard makes of automobile piston pins.

The method consists of placing a number of piston pins loosely on a quick loading spider which is located between two lapping wheels rotating on vertical axes. Both wheels rotate in opposite directions, and at a slightly different speed.

The illustration shows the spider in the loaded position, and the piston pins are resting on the lower wheel. When lapping, the upper wheel is brought down onto the pins under pressure, and the variations in wheel speeds cause the pins to rotate between the lapping wheels and creep slowly in a circular path.

The projecting arms on the spider are not radial with the center of the spider, thereby causing the piston pins when rotating to have a rotating sliding action between the wheels. The center of the spider rotating on an eccentric, gives three distinct actions of the work on the wheels:

First: The creeping of the work caused by the variation in wheel speeds.

Second: The sliding rotating action caused by the work being set on an angle instead of being radial to the center of the wheel.

Third: The eccentric spider motion giving an in and out sliding action of the piston pin from the center of the wheel.

This process furnishes a finished surface which is highly polished and absolutely free from grooves. This highly finished accurate surface is obtained through two operations, one of rough lapping, and the other of finish (polish) lapping. The rough lapping is obtained by the use of a fine grinding wheel, while the finish lapping is obtained through a soft elastic wheel giving a highly polished surface. The roundness is easily kept within .0001, the taper variation in the length, .0001, and the diameter plus or minus .0001. This method not only provides for extremely accurate work, but the high wheel speeds used provide for 30 per cent more production than in any other method used to date.

The machine is made with two wheels located on vertical axes and independently driven from a pulley shaft at the rear of the machine. The wheels are located in separate heads mounted on an extra heavy column. The lower wheel has no vertical adjustment in the head, while the upper one slides vertically. The vertical movement of the upper wheel spindle is controlled from a pilot hand wheel on the side of the machine similar to the standard drill press operation.

The wheel bearings are well proportioned, while the spindle journals are hardened and ground. The end thrust of both wheels is taken by ball thrust bearings. Close attention is paid to the careful aligning of the wheel spindle, and with the extra heavy construction, provides for continued accuracy.

A double end diamond wheel dresser is located on the left side of the machine. This permits both wheels to be dressed independently from the same mechanism, which is operated by a hand wheel conveniently located for the operator.

A pump is completely piped from a water tank to the wheel spindle, and furnishes a constant flow of lubricant on the work. A special compound is used to prevent rusting. Also, when the upper wheel is lowered onto the work, a circular guard surrounding the work and the wheel is automatically raised and guards the compound from flying off from the wheel.

Tells of Progress of Pressed Metal

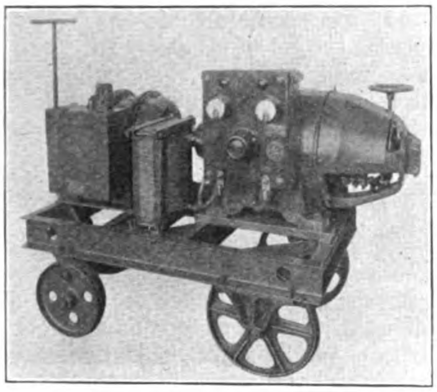
Douglas P. Cook, president of the Boston Pressed Metal Co. of Worcester, Mass., addressed a dinner meeting of the New Britain Branch, A.S.M.E. at the Connecticut State Trade School in New Britain on the evening of Thursday, May 22.

Mr. Cook's subject was "Pressed Steel Engineering"; being part of the paper read by him before the New York society in December. In the course of his remarks the speaker directed the attention of his audience to the numberless instances in which pressed metal parts are taking the place of gray iron and brass castings, die-castings, and in many cases even of screw machine products. He showed how the substitution had brought about reduction in weight, increase in strength and saving in cost of machining, as well as adding to the symmetry of design.

The talk was illustrated by slides, each one showing a part made of pressed steel and the casting or screw machine part it had superseded. A motion picture was also shown, exemplifying in action the many intricate drawing, swaging and stamping operations that go to make up a complex part of sheet metal.

New Portable Arc Welder

This welder is a two-unit set, consisting of a motor and a generator. The generator is self-excited, thereby eliminating the necessity of a separate exciter. All regulation of current is accomplished by turning a handwheel on the generator. A self-adjusting, stabilizing reactor is provided, which automatically steadies the arc under all welding conditions.



The new welder is made by the General Electric Company. It can be used with any of the commercial sizes of metallic electrodes from 1/16 in. to ¼ in. diameter. Generator voltage can be adjusted to suit the character of the work. High voltage for complete penetration on heavy work and low voltage to prevent burning through on light work are thus secured at will. Any value of current between 75 and 300 amperes can be obtained in a large number of steps between these limits.

Among the operating advantages of this outfit are: An arc easy to start and maintain, roller bearing wheels, holes in base for crane hooks and adaptability to long or short leads, for working close by or at a distance from the set.

Among mechanical advantages are included motor and generator insulation designed to withstand severe operating conditions both with regard to duty cycle of the load imposed and general atmospheric conditions under which ordinary insulation fails. Bearings are waste-packed and oil cannot be spilled if the set is tipped when being moved.

This WD-12 generator is a two-pole, self-excited, constant energy, single-operator machine with a dual magnetic circuit designed to operate at 60 volts open circuit and 20 to 25 volts under load. It is rated 200 amperes for continuous service, 250 amperes for one hour and 300 amperes for short periods. The motor is a standard General Electric 10-hp. unit. The complete set has three bearings, the two units being close-coupled by a solid flange coupling. All parts, including generator, motor, generator control panel, motor starter and stabilizing reactor, are mounted on a welded structural steel base of rigid construction and light weight.

The assembled unit is about 63 inches long, 29 inches wide and 47 inches high, weighing about 1600 pounds.

The Economy Fuse & Manufacturing Company, Chicago, Ill., announces the appointment of Morgan P. Ellis as General Sales Manager. Mr. Ellis has been Assistant General Sales Manager for the past eight years.

The Endicott Forging & Manufacturing Company, Inc., Endicott, N. Y., manufacturers of Drop Forgings, has installed a Mesta Pickling Machine. A brick building has been added to the shipping room to accommodate same.

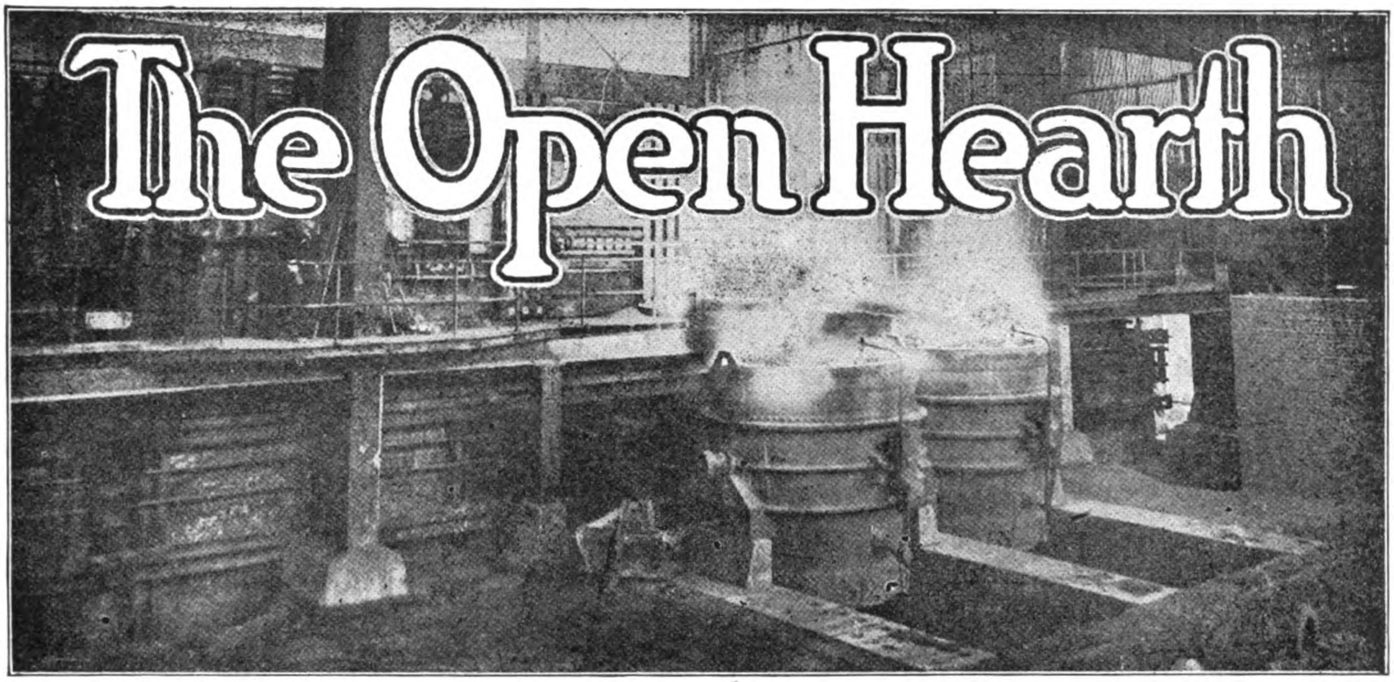
Science in the Use of Nails

The old proverb "a stitch in time saves nine" applies as pointedly to nails as to needles, says John F. Keeley, packing expert of the Department of Commerce, who is conducting, in co-operation with shipping industries, an exhaustive investigation of means of prevention of loss of goods in transit. That a timely nail is worth more than its weight in gold has been proved by tests of packing cases at the United States Forest Products Laboratory which show that the majority of failures of ordinary boxes is due not to the lumber of which the box is made but to improper nailing. In many cases a better box can be constructed with thinner material by the use of a few more nails in the right places, making a material saving in initial cost of packing as well as subsequent saving through less loss in the box car and on the concrete platform.

In making a packing case the nailer must use his own head as well as the nail's declares Mr. Keeley. The proper nailing of boxes demands the use of the right kind of nails, the right size and the right number. The sizes and thickness of nails are determined by species of wood and thickness of boards. The woods commonly used for box-making purposes have been divided by the Forests Laboratory into four classes according to their strength and their ability to take and hold nails with white pine leading group one, southern yellow pine leading group 2, red gum leading group 3 and hard maple leading group 4. The number and size of nails needed to make strong boxes out of the various woods of different thicknesses have been reduced to regular rules and charted. Charts by which anybody who can read may know just what nails to use and how many and where for every common kind of box wood have been prepared by the Commerce Department and may be had by anybody who will write to the department and ask for it. This chart pasted up in the shipping room and used means money for the user.

"Spare the nail and spoil the box" is Mr. Keeley's motto. The number of nails specified for different woods in the chart is not the maximum. Increasing the number of nails 50 per cent will increase the strength of the box 10 per cent on the average. The danger of splits from driving two or three times the number of specified nails is negligible. Nails are cheaper than wood. They not only serve to hold parts of a box together, but they provide rigidity. Splitting is more often caused by too large than by too many nails. With the Commerce Department chart showing the size and minimum number of nails necessary the box-maker will not go far wrong.

The syndicate of firms owning the Millholland Machine Company of Indianapolis, Indiana, having passed through a receivership the Millholland Company was recently forced to liquidate. The plant buildings and equipment were sold and will be devoted to other lines of business. Gisholt Machine Company purchased the business including their stock of finished machines, the parts in process, good will, trade-marks, patents, patterns, drawings, jigs, tools, fixtures, etc., and will continue at Madison, Wisconsin, the manufacture and sale of Millholland Machines which have gained an enviable reputation throughout the manufacturing world.



The Open Hearth

Robert J. Anderson has resigned as metallurgical engineer of the U. S. Bureau of Mines, and is now engaged in general consulting engineering practice. Specializing in the metallurgy of aluminum. His address is P. O. Box 111, Fenway Station, Boston, Mass.

George Hatton, managing director of the Earl of Dudley's Round.Oak Steel Works. Dudley, England, has been appointed chairman of the Midland iron and steel wages board to succeed the late George Macpherson. The newly elected chairman is a commander of the British Empire, a distinction awarded for services rendered during the war and has for many years been a member of the council of the Iron and Steel Institute. He is regarded as a great authority on the Staffordshire iron trade. The Midland board has the distinction of having maintained peace throughout the industry in Midland, Yorkshire and South Wales areas for something like 40 years. Mr. Hatton is considered eminently suitable for the chair, having the confidence of the operatives as well as the employers' section.

Gunnar Starck, Sweden, metallurgical engineer, who is in America for the purpose of study, for the past year or so with the Morgan Construction Co., Worcester, Mass., in its assembling department, is in Chicago. From Chicago he plans to visit Pittsburgh. He will spend about five years in this country for the purpose of qualifiying for head of one of the largest Swedish steel mills.

W. S. Greenawalt has been appointed open-hearth superintendent of the Otis Steel Co., Cleveland. He was formerly connected with the Pittsburgh Steel Co., and the Cromwell Steel Co. in a similar capacity.

Dr. Francis M. Walters, Jr., for the past two years connected with the U. S. Bureau of Standards in Washington as associates physicist, has been appointed director of the special research bureau of metallurgy, which has just been established by the Carnegie Institute of Technology. Dr. Vsevelod N. Krivobok, metallurgist, has been appointed an assistant. The object of the new department is to apply to metallurgy recent discoveries in physics and chemistry. Work of the bureau will begin early in September.

Mr. William Shaup has been appointed Superintendent of Open-hearth, La Belle Works of the Wheeling Steel Corporation, Steubenville, Ohio., succeeding W. W. Welch, resigned.

Witherbee-Sherman & Company, who recently blew out their new "B" blast furnace at Port Henry, New York, have contracted with Arthur G. McKee & Company, Cleveland, for a McKee Revolving Distributor, which will be installed on this furnace before its next campaign.

The Chapman-Stein Furnace Co., of Mt. Vernon, Ohio, has just completed a car type recuperative normalizing and annealing furnace for The Buckeye Steel Casting Company, of Columbus. The furnace will have a capacity of ten tons per charge and will be used for annealing steel castings. It is now being fitted for oil burning and will be fired in about three weeks. This furnace will be of considerable interest to the trade in that it is equipped with a Chapman-Stein refractory tile recuperator which will utilize the heat in the waste gases to preheat the air for combustion. Only 5 to 10 per cent of the air necessary for combustion is used as compressed air and passed through the burners. The remainder of the air heated to a high temperature is supplied by the recuperators without the use of a fan.

J. F. Buhr has opened an office in the Blodgett Engineering & Tool Company Building, at 14th and Dalzelle Sts., Detroit, Mich. The J. F. Buhr Machine Tool Company will act as sales representatives for the Blodgett Engineering & Tool products. The outstanding item of these is the Buhr Ball Bearing Fully Adjustable Multiple Driller. The Blodgett Engineering & Tool Company also specialize in fine tool and die work.

William Swindell & Brothers announce the removal of their general offices on June 1, 1924, to their new office building on Freeport Road, near Aspinwall, Pa.

Some Pointers on By-Product Coke Oven Operations

New Clairton Coke Ovens in Operation

The first coke was taken from the newly installed by-product coke ovens at the Clairton plant of the Carnegie Steel Company recently. The plant had been under construction nearly two years and is classed as one of the largest pieces of construction work of its kind carried on in this district since the building of the original by-product coke plant at Clairton.

The new plant began operation six years to a day from the time the original plant was put into operation. It consists of 366 ovens arranged in six batteries of 61 ovens each and has a capacity to carbonize 8,500 tons of coal a day. It will produce daily 6,000 tons of coke, 55,000,000 cubic feet of gas, 90,000 gallons of tar, 215,000 pounds of ammonium sulphate and 25,000 gallons of benzol products.

With the newly completed addition the by-product plant at Clairton is the largest in the world, according to the officials of the company. The total number of ovens, with extensions, is 1,134.

The newly finished ovens embrace many radical improvements. Joseph Becker, consulting engineer of the Koppers Company, is the inventor of the ovens, which were first introduced into this country in 1922.

The U. G. I. Contracting Company has just received contract from the Lima Gas Light Company, Lima, Ohio, for a complete 9-ft. set of carburetted water gas apparatus, 150-hp. water tube boiler and feedwater heater, tar extractor, tar separator and filter, including all foundation work.

Explosion Hazards of Pulverized Coal

An investigation of the explosion hazards in industrial plants using pulverized coal as fuel, which has been conducted by the Department of the Interior, through the Bureau of Mines, for the past several years, has been completed. Practically all the important plants using such fuel were visited, and the installations closely studied for safety conditions and the means employed for eliminating possible hazards. In some plants the Bureau of Mines engineer was able to point out dangerous conditions, and practical changes for their abatement. The results of this research show that the causes of an explosion hazard are similar to those from coal dust in mines. Means of combatting them are to prevent clouds of coal dust from getting into the air, and to eliminate possible sources of ignition. A report giving the result of this investigation will be issued by the Bureau of Mines within the next few months.

Coal Cleaning Studies

Specific problems in coal beneficiation which come to the attention of the Department of the Interior and which are considered to be of general interest, rather than an individual operator's special problem, are investigated by the Central District experiment station of the Bureau of Mines, Urbana, Ill., in order to further the better preparation and more conservative use of the fuel. In these investigations samples of the coal in question are examined in order to determine the nature of the impurities and the improvement that may be expected in treating the coal by a cleaning process. Tests are being made with the pneumatic table on a number of Eastern and Central District coals to ascertain the effectiveness of this method of treatment and its suitability for different types of coals. A general study of the dry cleaning process is being made in an effort to apply such methods in coal preparation work and to develop a simple method of treatment.

Methods used by a number of large manufacturers to control their investments in raw materials are set forth in a pamphlet just issued by the Department of Manufacture of the Chamber of Commerce of the United States.

In commenting on the importance of this subject and the contents of the pamphlet, E. W. McCullough, manager of the department, said:

"Early in 1922 when industry generally had not passed the period of industrial stagnation and inventories of raw and processed materials in the storerooms of manufacturers were excessive, executives pretty generally came to an appreciation of the importance of establishing firmer control over their materials investments. The subject is no less timely now. Although conditions have changed, the changed conditions have brought with them a greater need than ever for the closest control of every feature of the operation of manufacturing plants. There is now the necessity for the highest operating efficiency to meet the present keen competition. Any plans the manufacturer can adopt still further to reduce his investment in materials; to effect a firmer control over the use of materials; and to gain greater knowledge of his business most surely will met with his approval. We have developed a pamphlet of helpful suggestions to assist the manufacturer in the development of an adequate plan of control.

"This pamphlet is based on the experiences of a considerable number of manufacturing companies that have developed satisfactory methods of control, hence it is not a textbook on the subject, but rather it reports the tested procedure of these manufacturers in connection with the various phases of the general subject.

"Doubt has been expressed by some manufacturers, for example as to whether it is safe to do away entirely with the year-end physical inventory. This point is covered, and the actual procedure followed whereby the annual physical inventory is eliminated is presented."

A copy of the pamphlet will be furnished upon request.

NEWS OF THE PLANTS

The Bethlehem Steel Company, Bethlehem, Pa., has had plans drawn for additions to its plant at Sparrows Point, Baltimore, Md., consisting of three one-story structures of different sizes, estimated to cost approximately $100,000, including equipment. These buildings are said to be the first of a number of other groups which the company purposes to erect at the local mills, and it is expected to have plans ready for further extensions in the near future. Plans are also being developed for the proposed expansion at the Cambria Works, Johnstown, Pa., estimated to cost close to $10.000,000, complete. This work will consist of the remodeling of present mills, erection of additional structures and the installation of considerable new machinery for the complete modernizing of the plant in all departments.

The Pacific Coast Steel Company, Seattle, Wash., has work in progress on additions to its plant at Youngstown, near Seattle, consisting of the installation of a new universal mill, shears and other equipment. The new mill will be used for the rolling of universal plates from 8 to 20 in. wide and ¼ to ¾ in. in thickness. It is expected to develop considerable increased capacity as soon as the new addition is ready for service, now slated to be in October. The company has recently started the rolling of tie plates at the plant, and will expand this branch of production as required, the present works have a rating of more than 400 tons of finished steel products per day. E. M. Wilson is president and treasurer; and T. S. Clingan, general manager.

The Carnegie Steel Company, Carnegie Building, Pittsburgh, Pa., is perfecting plans for extensions and improvements in its plant at New Castle, Pa., to cost about $1,000,000, including equipment. The project will include the erection of several new buildings to provide for increased output in a number of departments, as well as the modernizing of the boiler plant and the installation of additional boilers and auxiliary power equipment. It is expected to begin work at an early date.

The Youngstown Sheet & Tube Company, Youngstown, Ohio, is proceeding with the construction of a new 600-ton blast furnace at its plant at Indiana Harbor, Ind., comprising the former works of the Sheet & Tube Company of America, acquired a number of months ago. It is expected to have the new unit ready for blowing in at an early date, providing for a large increase in the former capacity. Work is also under way on a new lap weld mill, as well as other miscellaneous structures arranged for in an expansion program recently approved for the plant, involving in excess of $4,000,000, in buildings and equipment. The company will place two new butt weld mills in service, recently completed, designed to roll pipe from ⅛ to 3 in. in diameter.

The Central Furnace Company, Massillon, Ohio, a subsidiary of the Central Steel Company, of the same city, will proceed at once with an expansion and improvement program at the local plant, for which a fund of close to $10,000,000, is being arranged. The work will include a new blast furnace, by-products coke plant, auxiliary steel works, power plant and other miscellaneous buildings, to provide for a large increase in output. The expansion is expected to give facilities for the employment of about 4,000 additional men in the different departments, and practically all of the buildings are to be ready for service in about 12 months. A list of machinery and equipment to be installed in the new buildings will be arranged at an early date.

The Union Tube Company, Cleveland, Ohio, is now being organized under state laws with a capital of $300,000, to take over and develop the plant of the Cleveland Steel Tube Company on 21-acre tract of land near Miles Avenue, S. E., and 144 Street, near the line of the Erie Railroad Company. The new company is headed by Morris G. Songer, Pittsburgh, Pa., engaged in the steel jobbing business, and a number of associates. The plant was constructed in 1920 and designed for the manufacture of butt weld pipe; it was owned by the International Steel Tube Company, which had financial difficulties before the plant was placed in service, and it was later taken over by the Cleveland Steel Tube Company, headed by Jacob Kahler and associates. The new company purposes to modernize the plant in all departments for the production of butt weld tubing, and will add new equipment for this manufacture. It is said that about three to four months will be required to place the mill in satisfactory shape.

The Burden Iron Company, Troy, N. Y., has disposed of a preferred stock issue of $700,000, a large part of the proceeds to be used for the purchase of a substantial interest in the Hudson Valley Coke & Products Company of the same city. Plans are being arranged by the last noted organization for the establishment of a central gas distributing works in the vicinity of Troy for service to public utility companies in this section. The Burden company will exercise its control of the company in connection with the project of the Troy Coke & Iron Company, recently organized as a subsidiary, which proposes to construct and operate a blast furnace and by-products coke plant in this same district. The Hudson Valley company, it is understood, will be used as the distributing organization for the by-products of the mills. The new coke plant will be constructed by the Foundation Company, New York, which is financially interested in the project.

The Replogle Steel Company, 120 Broadway, New York, headed by J. Leonard Replogle, operating blast furnaces at Wharton, N. J., is arranging for an extension of interests and has secured options for the purchase of the plant and business of the Warren Foundry & Pipe Company, Phillipsburg, N. J., for a consideration stated to be $4,000,000. The company is also said to be negotiating for the acquisition of the plant and property of the Donaldson Iron Co., Emaus, Pa., and proposes to expand these works to be operated, as in the case of the Warren company, in connection with its Wharton works.

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The Blast Furnace and Steel Plant

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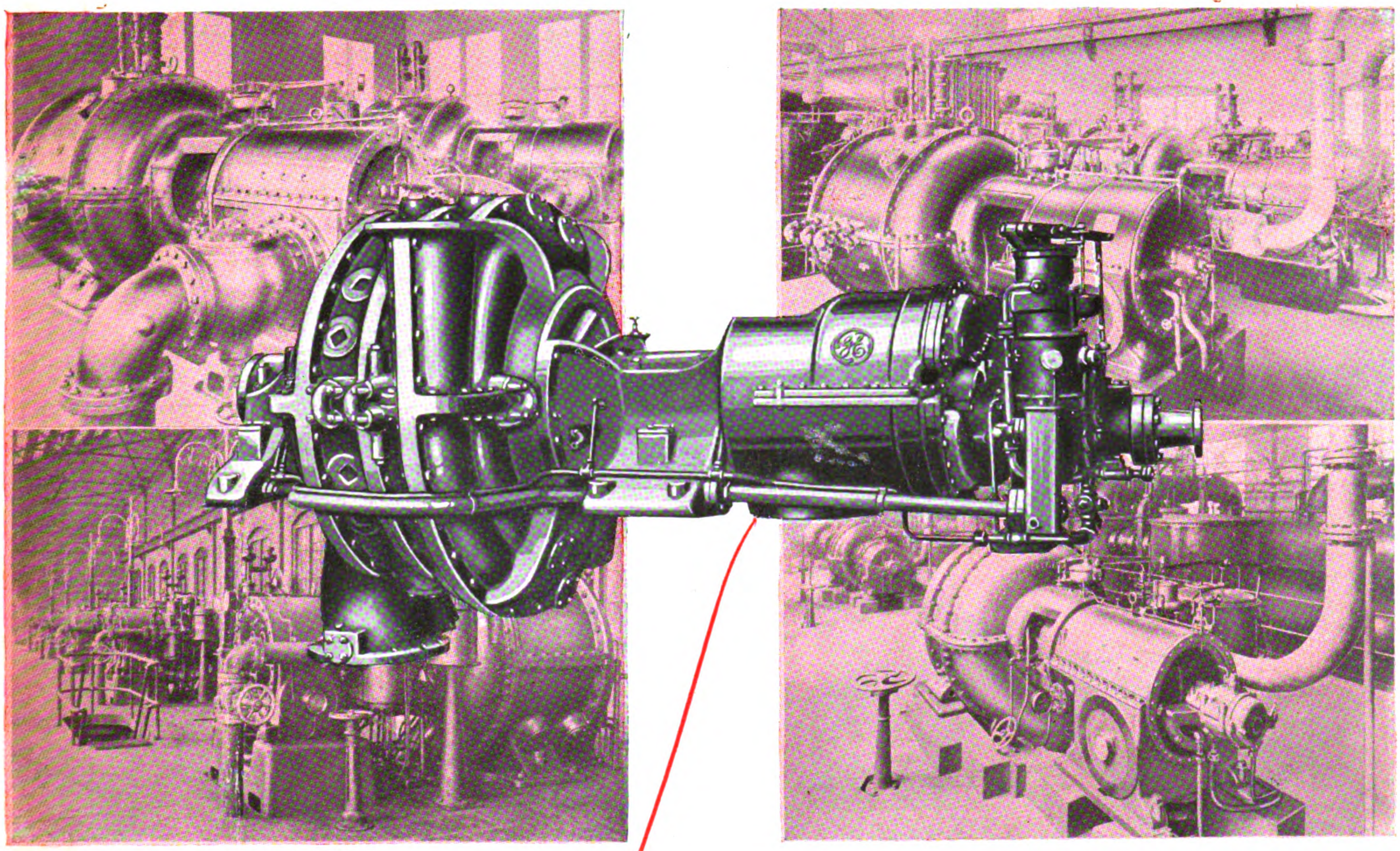

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